GREENSVILLE COUNTY PLANNING COMMISSION

AGENDA

Tuesday, November 13, 2018

6:00 p.m.

I. CALL TO ORDER

II. ROLL CALL

III. APPROVAL OF AGENDA

A. Approval of Minutes – See Attachment - A.

1. October 9, 2018

IV. PUBLIC HEARING

A. SP-5-17 Revocation of Special Use Permit – Sedrick Miles – See Attachment - B.

V. REGULAR SESSION

A. SP-5-17 Revocation of Special Use Permit – Sedrick Miles

VI. OTHER MATTERS

A. SP-2232-3-18 Fountain Creek Solar – See Attachment – C.

1. Staff Report

2. Presentation by Applicant

3. Citizen Comments

4. Follow-up Comments by Staff

5. Discussion/Deliberation by Planning Commission

6. Action by Planning Commission

IX. ADJOURN

The Greensville County Planning Commission meeting was held Tuesday, October 9, 2018, 6:00 P.M., at the Golden Leaf Commons, 1300 Greensville County Circle, Emporia, Virginia.

PRESENT
Walter Robinson, Vice-Chairman
Lofton Allen
Joe Antorn, Jr.
Annie Odom
Dianne Barnes-Rhoades
Jeff Robinson

ABSENT
Stephen Allen
Peggy Wiley

STAFF PRESENT
Linwood E. Pope, Jr.
Treva Pernell

OTHERS PRESENT
Allen Little

Vice-Chairman Robinson called the meeting of Tuesday, October 9, 2018 to order. Mr. Robinson stated that the Commission would start the meeting with prayer. He called on Commissioner Jeff Robinson to offer prayer. The secretary called the roll.

In Re: APPROVAL OF THE AGENDA

Mr. Pope stated that staff recommended adding two items to the agenda. He asked that Public Comments and Other Matters be added.

Vice-Chairman Robinson entertained a motion for approval of the agenda with two added items. Commissioner Rhoades made the motion, seconded by Commissioner Jeff Robinson, with all voting aye, motion carried.

In Re: APPROVAL OF THE MINUTES

Vice-Chairman Robinson entertained a motion to approve the minutes of September 11, 2018. Commissioner Jeff Robinson made a motion, seconded by Commissioner Rhoades, with all voting aye, motion carried.

Vice-Chairman Robinson entertained a motion to go into Public Hearing. Commissioner Rhoades made the motion, seconded by Commissioner Antorn, with all voting aye, to go into Public Hearing.

In Re: PUBLIC HEARING

ZTA-3-18 Greensville County Board of Zoning Appeals

Mr. Pope stated that during the time he was out on sick leave, an applicant filed for a zoning ordinance amendment with the Board of Zoning Appeals in order to install a storage building in the front side yard of her home. He stated that, according to the Zoning Ordinance, this was not allowed. He also stated that her parcel was a non-conforming parcel (.68 acres). He further stated that the applicant owned an adjoining lot that was also a non-conforming parcel that had no structure; therefore, according to the Zoning Ordinance, no accessory building can be constructed upon a site without an occupied main building being present.

Mr. Pope stated that the applicant's request was in conflict with the Zoning Ordinance, therefore, the Board deferred case #V-1-18 for the Planning Commission and Greensville County Board of Supervisors in order to revisit section 3-4 of the Greensville County Zoning Ordinance related to accessory structure placement and setback requirements in an A-1 Agricultural Zoning District.

Mr. Pope stated that the Board of Zoning Appeals (BZA) did an outstanding job of following the rules set out in the Zoning Ordinance. He stated that the BZA asked that the Planning Commission look at this issue because, in this particular case, they did not feel it was a detriment to surrounding properties.

Mr. Allen Little, Chairman of the BZA, addressed the Commission and stated that if this had been a subdivision it should not be allowed. However, he felt that this applicant had so much land and no surrounding property owners that it would affect, he was hoping that some "tweaking" of the ordinance could be done to allow this in some areas.

Mr. Pope stated that this is not a hardship case. He stated that he felt the placement of accessory buildings be limited to side and rear yards of individual lots.

Mr. Pope stated that he had contacted surrounding localities and found that the County's Ordinance was consistent with those localities. He stated that staff has reviewed the Zoning Ordinance as requested by the BZA and recommends no changes be made to the Greensville County Zoning Ordinance. He also stated that should the Planning Commission position on this matter differ from the staff's opinion, staff will be glad to draft regulations as directed by the Planning Commission and present them at a future meeting of the Planning Commission for consideration.

Vice-Chairman Robinson stated that the County Zoning Ordinance had been working well since its inception and re-drafting in the 1990's.

Vice-Chairman Robinson entertained a motion to go back into regular session, Commission Robinson made the motion, seconded by Commission Rhoades, with all voting aye, motion carried.

In Re: REGULAR SESSION

Vice-Chairman Robinson entertained a motion concerning ZTA-3-18. Commissioner Rhoades made a motion that the Planning Commission leave the Greensville County Zoning Ordinance Article 3-4 as it is currently written, seconded by Commissioner Antorn, with all voting aye, motion carried.

Mr. Pope stated that staff would schedule this case be heard again by the Board of Zoning Appeals at their next meeting.

Vice-Chairman Robinson opened the meeting to public comments.

In Re: PUBLIC COMMENTS

Mr. Allen Little addressed the Commission and stated that he was not clear on how much can happen with solar projects in the County. He asked how that happens and who decides.

Mr. Pope stated that, right now, there was no limited on the total acres in the County. He stated that each case is heard individually and there are not regulations in place at this time.

Commissioner Jeff Robinson stated he had a conversation with David Stoner (Fountain Creek Solar) and Mr. Michael Ferguson, Chairman of the Board of Supervisors. He stated that question was asked and the answer was the only threshold was the capacity of ground station; that would be the limiting factor as opposed to real estate in the Brink community.

Mr. Pope stated that the state and federal government require Dominion and other power providing companies obtain a certain percentage of their power from "green type" power sources.

Mr. Little stated he is not pleased that the solar projects were approved for several reasons; proximity to homes, uncertainty of toxicity, danger of flying debris during hurricanes, etc. He stated that in some meetings he attended, attorneys for the applicants stated that in the Greensville County Comprehensive Plan solar projects were encouraged. He asked if the solar industry is being encouraged to come into the County. He asked that the wording in the Comprehensive Plan be discussed and changed if need be.

Mr. Pope stated that there were large scale projects (20 megawatts and greater) and small scale projects (under 20 megawatts). He stated that the intent was to limit the small scale projects to only industrial and business owned districts where they are not in conflict with surrounding land uses. He stated that large scale solar projects are only encouraged in A-1, Agricultural districts where they are not in conflict with surrounding land uses.

Commissioner Jeff Robinson stated that he would like to see the language in the Comprehensive Plan "tightened up" before the next solar project comes before the Planning Commission.

Mr. Pope stated that he would keep the Commission advised on the upcoming revisions to the Comprehensive Plan.

Mr. Michael Ferguson addressed the Commission and stated that he had concerns about ZTA-3-18. He stated that he had discussed the situation with the applicant and could see her point of view and concerns.

Mr. Pope stated that the request would go back to the Greensville County Board of Zoning Appeals.

In Re: ADJOURN

There being no other discussions, Commissioner Robinson made a motion to adjourn, seconded by Commissioner Lofton Allen, with all voting aye, motion carried and meeting was adjourned.

_____

Walter W. Robinson, Jr.
Vice-Chairman

ATTACHMENT B

COUNTY OF GREENSVILLE
BUILDING & PLANNING DEPARTMENT

TO: Planning Commission Members

FROM: Lin Pope, Planning Director

RE: Re: SUP-5-17 Sedrick Miles

DATE: November 7, 2018

On January 15, 2018 the Greensville County Board of Supervisors approved Mr. Miles Special Use Permit Request to establish an automobile repair facility within an existing enclosed accessory structure. The request was approved subject to the following ten conditions:

1. A Special Use Permit is granted to the applicant for the establishment of an automotive repair facility within an existing enclosed accessory structure on property known as Greensville County Tax Map 22, Parcel 21D.

2. At all times be in compliance with all local, state, and federal rules, regulations, ordinances, and laws.

3. Obtain a Building Permit for the existing garage that was recently constructed.

4. Submit to any inspections or structural requirements necessary to convert the private garage into a commercial facility.

5. Proper container for used automotive fluids shall be maintained at the site at all times and appropriately serviced.

6. Employees shall be limited to the present applicant and one (1) full time employee.

7. Customer access shall not occur prior to 7:00 a.m. or after 10:00 p.m. Any automotive repair activity occurring between 10:00 p.m. and 7:00 a.m. may be conducted provided the garage workshop is closed.

8. No outside storage of parts, supplies, or customer's vehicles is permitted.

9. One (1) freestanding project sign no larger than 25 square feet and no taller than four (4) feet may be erected on site.

10. Utilizing this permit issuance date as the annual date, if the proposed use is not established within two (2) years, or is abandoned for two (2) consecutive years, this permit will be automatically terminated.

11. Failure to abide by the above conditions may result in the immediate revocation of the permit.

As of the date of this memo, Mr. Miles has failed to meet SUP's required conditions. On June 26, 2016 and November 1, 2018 Notices of Violation were sent to Mr. Miles to inform him that the subject conditions have not been met.

The Greensville County Building Department is requiring Mr. Miles to obtain the services of a licensed engineer to determine if the structure meets the code requirements for a commercial garage and/or determine what modification must be made to the garage in order to conform to the building codes. The engineers report has to be completed before the Building Department can issue a building permit for the garage. In addition to becoming code compliant there is also the presence of numerous inoperable vehicles on the site which are not allowed per condition #8 of the Special Use Permit.

The Planning Commission has two options. The first option is to revoke the Special Use Permit for failure to meet the permits conditions. The second option is to defer action and provide the applicant additional time to adhere to the permits conditions. On Monday, November 5th Mr. Miles met with me concerning the November 1, 2018 violation letter he received. I provided Mr. Miles with contact information for engineers who could assist him in meeting the Building Departments requirements for the garage. Should the Planning Commission decide to defer action to revoke Mr. Miles' Special Use Permit, staff recommends only deferring for a 30 day period and revisit the case at the December meeting to ensure that Mr. Miles is making progress towards being compliant with all local regulations.

LEP, Jr./tcp

Staff Report
Fountain Creek Solar Project
Public Facility Application Review for 2232-3-18
Code of Virginia § 15.2-2232
Greensville County, Virginia

November 6, 2018

APPLICATION SUMMARY

Project:	Fountain Creek Solar Project
Location:	Located on Brink Road (Rt. 627) bound by Fish Road, Fountain Creek Road (Rt. 659), and adjacent farmland approximately 8 miles southwest of Emporia in Greensville County, Virginia.
Parcel Record Numbers:	41-16, 41-17, 42-48, 42-49, 42-50, 42-53, 42-3-A, 42-54
Proposal:	Applicant's request for review of the Fountain Creek Solar Project pursuant to Virginia Code Section 15.2-2232
Application Submitted:	October 8, 2018
Applicant:	Fountain Creek Solar, LLC / Clearway Energy Group, LLC 100 California Street, Suite 400 San Francisco, CA 94111 Contact: Aarty Joshi
Representative:	David Stoner, Kimley-Horn and Associates, Inc. 421 Fayetteville Street, Suite 600 Raleigh, North Carolina 27601
Owners:	See Attachment A – 2232-3-18 Application, sub-attachment B Property Owner Information, Site and Transmission Line Parcels

PLANNING COMMISSION ACTION

The Applicant has requested that the Planning Commission review its proposed solar energy facility, as a "public utility facility" under Virginia Code Section 15.2-2232(A), to determine if the general or approximate location, character, and extent of the proposed facility is substantially in accord with the County's Comprehensive Plan. As required by the Zoning Ordinance, the Applicant submitted a 2232 Review Application (County reference number: 2232-3-18) that was deemed complete on October 8, 2018, proposing a solar photovoltaic generation facility. Staff has recommended that the Planning Commission review the request for determination under Virginia Code Section 15.2-2232 prior to any review of a special use permit (SUP) application. For reference, Fountain Creek's 2232 application materials are attached (Attachment A) to this staff report.

The issue presented to the Planning Commission is whether the general or approximate location, character and extent of the proposed solar energy facility is substantially in accord with the County's Comprehensive Plan or part thereof. Subject to the Planning Commission's 2232 decision, **the Planning Commission will separately review and consider the merits of any associated SUP Application.**

PROPOSED DEVELOPMENT

The Applicant proposes to construct a 80 megawatt (alternating current) photovoltaic solar energy generation facility on two (2) parcels consisting of a total of approximately 802 acres. The solar panels will cover approximately 595 acres. The site currently consists of fields, farm paths, wooded areas, and natural wetlands.

The project includes a 2.2 mile interconnection transmission line through similar terrain affecting six (6) additional parcels. The solar energy generation facility will be connected to the Dominion Power power grid at a new interconnection point on an approximately 2-acre parcel. The interconnection switchyard will be approximately 200'x200' in dimension, fenced, and include transmission structures not exceeding 75' in height, breakers, and ancillary equipment.

The proposed site is in the same vicinity of the recently approved Meherrin 60 megawatt solar generation facility to the east of Fountain Creek Road. The shortest distance between the two developments will be approximately 600 ft (the length of parcel 42-45A).

The applicant provided a list of project benefits, including:

- Jobs during construction and operation
- Revenue generation and economic benefits
- Community benefits
- Environmental benefits

The applicant also provided a list of potential impacts and mitigation measures, including:

- Traffic during construction
- Construction noise
- Security lighting
- Wetland impacts

PURPOSE OF THE REVIEW UNDER VIRGINIA CODE SECTION 15.2-2232

Virginia Code Section 15.2-2232 requires that the Planning Commission review all proposed developments that include a "public utility facility" prior to the construction or authorization of such facility. The purpose of the Planning Commission's review is to determine if the general or approximate location, character, and extent of the proposed public utility facility is substantially in accord with the Greensville County Comprehensive Plan or part thereof. The Planning Commission has set aside time at its November 13, 2018 meeting to afford citizens an opportunity to offer their comments to the Planning Commission. The Planning Commission must advise the Board of Supervisors of its determination. If appealed by the Applicant, the Board of Supervisors may overrule the action of the Planning Commission.

EXISTING CONDITIONS AND ZONING

The application property consists of a mixture of cleared land, crop land, and existing timber land with the land historically used for agricultural and forestry purposes. The application property is currently zoned A-1, agricultural zoning district.

ADJACENT AND SURROUNDING USES

The application property is bordered by existing agricultural land consisting of a mixture of cleared land and existing timber land, as well as a few single-family residential properties. The application property is located in an agriculturally zoned area (A-1) and is not proximate to any scenic byways or known historic resources. The future land use designation for the application property is Rural Residential.

COMPREHENSIVE PLAN CITATIONS

Below are the relevant excerpts of Greensville County's Comprehensive Plan.

Goals and Objectives

GENERAL

1) Provide adequate governmental services, including public utilities, to meet the needs of Greensville's citizens.
2) Coordinate development with the provision for public utilities and services.
3) Preserve the rural character of the County by directing and controlling growth in designated areas.

LAND USE GENERAL

1) Encourage new development that complements surrounding uses.
2) Concentrate development in appropriate locations by encouraging more efficient site design and incorporating proper buffers between differing uses.

RESIDENTIAL

3) Prevent the encroachment of conflicting land uses on existing viable neighborhoods.

COMMERCIAL/INDUSTRIAL

5) Evaluate large scale industrial economic development projects that will provide an economic benefit to the County but that may not be in designated development areas or near major transportation systems.

PUBLIC FACILITIES

3) Plan accordingly for the future needs of the population.

Planning Issues & Strategies

LOCAL PRODUCTION OF RENEWABLE ENERGY

1) There is a great interest in the construction of Solar Energy Farms throughout the County as a result for the quest to generate environmental friendly energy.

STRATEGIES/POLICIES

a. If not detrimental to the surrounding area, Solar Energy Projects greater than 20 MW_{AC} are encouraged in agricultural zoned districts.
c. It is encouraged that a Decommissioning plan be provided by the owner of such Solar Energy Projects to ensure to proper dismantling of the project.

AGRICULTURAL AND FORESTAL LANDS ISSUES

1) There is concern to maintain the agricultural characteristics of the County not included in the Urban Services District.

STRATEGIES/POLICIES

a. Re-evaluate current development standards to ensure all areas that lie within the Rural Development Area, with the exception of Major Commercial Hub, maintain these agricultural and rural development qualities.

Future Land Use Map

The Comprehensive Plan describes Rural Residential; Conservation Area as follows:

> Characterized by low-density residential development such as detached single-family units on lots larger than urban or suburban lots. Certain agricultural and farming uses are typically allowed. In addition, large scale economic development projects may be allowed subject to required land use approvals as approved by the Board of Supervisors.

STAFF COMMENTS AND ANALYSIS

A. Applicant's Position

In the application materials dated October 8, 2018 (Attachment A), the Applicant's Representative sets forth its reasons why the proposed project is substantially in accord with the Comprehensive Plan.

The Applicant identifies the following items in support of its project:

Supports General and Land Use Goals:

- Preserve the rural character of the County by directing and controlling growth in designated areas (general)
- Encourage new development that compliments surrounding uses
- Concentrate development in appropriate locations by encouraging more efficient site design and incorporating proper buffers between differing uses
- If not detrimental to the surrounding area, Solar Energy Projects greater than 20 MWAC are encouraged in agricultural zoned districts.

Supports the Rural Character of the County:

- Setbacks of 150 feet
- Landscape screening of 50 feet
- Wildlife corridors
- Maximum height of 15 feet (for non-transmission equipment)
- Dark-sky compliant lighting
- Minimal noise
- Dust control at entrances

B. Staff Analysis

Staff has analyzed the proposed project in light of the changing nature of the County landscape with previous approvals for other photovoltaic solar energy generation facilities (See Attachment B).

1. The proposed site is in the same vicinity of the recently approved Meherrin 60 megawatt solar generation facility to the east of Fountain Creek Road. The shortest distance between the two developments will be approximately 600 ft (the length of parcel 42-45A). Together, these sites are approximately 4 miles from the recently approved 80 megawatt Greensville County Solar Project (Tradewind Energy Project). The two approved projects cover 1,945 acres with approximately 1,278 acres of solar panels. Adding this project would bring those totals to 2,747 acres with approximately 1,873 acres of solar panels within a total area of approximately 18,000 acres (i.e. 10% of the land around the Brink substation would be covered with solar panels). The County may want to consider limiting the concentration of facilities in one region to preserve the rural character and agricultural characteristics of the County.

2. The project includes a 2.2 mile interconnection transmission line affecting six (6) additional parcels and the associated viewshed (up to 75' towers/poles). Screening and buffers are not feasible around the 2.2 mile transmission line. This may further negatively impact the rural character and agricultural characteristics of the County.

3. Although the two (2) parcel site for the solar panels is zoned for agriculture, it appears that over half the land is forested. The applicant proposes returning the site to a pre-construction condition. As part of a SUP, the County may want to stipulate the restoration criteria (pre-timbered or post).

Staff has also analyzed the Comprehensive Plan elements and the proposed project appears to meet some, but not all, of the Comprehensive Plan's land use and renewable energy goals, objectives, and

strategies. Subject to the project's final design and construction, and based on the information reviewed for this report, staff finds that the proposed utility-scale solar facility may not be substantially in accord with the Greensville County Comprehensive Plan, or parts thereof.

1. The proposed location appears to be in accord with some of the land use goals and objectives set forth in the Comprehensive Plan.
    a. The project is in an agricultural zoned district.
    b. The project is not competing with other major land uses in desired locations.
    c. The project does not encroach on any existing viable neighborhoods (major subdivisions).
2. The character and extent of the proposed utility-scale solar project appears to be partially in accord with the Comprehensive Plan.
    a. The proposed design shows adequate screening and buffers around the Solar Energy Farm site; however, screening and buffers are not feasible around the 2.2 mile transmission line.
    b. The project would increase the concentration of utility-scale solar facilities in the Brink section of the County impacting the rural character of that area.
    c. Encroachment on differing land uses is minimized.

Staff and the Planning Commisison will desire to see a detailed grading plan as part of a Special Use Permit (SUP) application so that it can be properly evaluated as to site impacts, and there will be a condition requiring compliance with the grading plan when developing the property.

An approved plan for a solar facility should, as set forth in the Comprehensive Plan:

- **Preserve the rural character** of the County by directing and controlling growth in designated areas.
- Concentrate development in appropriate locations by encouraging more efficient site design and **incorporating proper buffers** between differing uses.
- **Prevent the encroachment of conflicting land uses** on existing viable neighborhoods.
- **Plan accordingly for the future needs** of the population.
- **If not detrimental to the surrounding area**, Solar Energy Projects greater than 20 MW_{AC} are encouraged in agricultural zoned districts.
- There is concern to **maintain the agricultural characteristics of the County** not included in the Urban Services District.

Further, during a SUP Application review process, the Decommissioning Plan should be closely examined to ensure that the interests of the property owners, adjacent owners, and the County are adequately protected by a Plan that ensures removal of the solar facilities after use thereof is terminated with restoration of the underlying land to its former condition (as defined by a SUP condition), along with fiscal assurances deemed adequate by the County to ensure successful implementation of the Decommissioning Plan.

- It is encouraged that a Decommissioning Plan be provided by the owner of such Solar Energy Projects to ensure to proper dismantling of the project.

In a Special Use Permit staff report, staff and the Planning Commission will identify and recommend conditions to mitigate the adverse effects of this utility-scale solar generation facility. Such conditions will include provisions addressing decommissioning, screening, buffering, wildlife areas, the grading plan, stormwater management, erosion and sediment control, among other considerations.

The question before the Planning Commission with this 2232 application is:

Whether the general location or approximate location, character, and extent of the proposed solar energy facility is substantially in accord with the Comprehensive Plan or part thereof.

- The Planning Commission should consider all relevant portions of the Comprehensive Plan in its analysis.
- Since it is anticipated that the solar facility could occupy the property for thirty or more years, and is essentially adjacent to a similarly sizerd solar facility, this duration, scale and concentration has the potential to change the rural character of the property and surrounding area and should be carefully evaluated by the Planning Commission.
- The Planning Commission should carefully and thoroughly document its reasons for whatever conclusion it reaches.
- The Planning Commission has three options:
    a. Approve the application with written reasons for its decision.
    b. Deny the application with written reasons for its decision.
    c. Defer the application for further discussion and consideration (within the 60 day window).

Attachments:

A – 2232-3-18 Application, dated October 8, 2018
B – Brink Community Map

DRAFT PLANNING COMMISSION ACTIONS

Option 1 – Applicant's proposal is substantially in accord with the Comprehensive Plan

I move that the Fountain Creek Solar, LLC's proposed 80-megawatt photovoltaic solar energy facility as described in 2232 Review application 2232-3-18, is substantially in accord with the Greensville County Comprehensive Plan or parts thereof for the following reasons:

1. The Comprehensive Plan notes an interest in the development of environmental friendly energy.
2. The Comprehensive Plan states that so long as a solar energy facility is not detrimental to the surrounding area, solar energy facilities are encouraged in agricultural zoned districts.
3. The proposed project involves only a small part of the total agricultural land in the County and has proposed setbacks and buffers which, if adequate in scope and required in the Special Use Permit, could afford protection for adjacent properties.

The Secretary of the Planning Commission is directed to communicate the Planning Commission's findings to the Board of Supervisors.

Option 2 – Applicant's proposal is not substantially in accord with the Comprehensive Plan

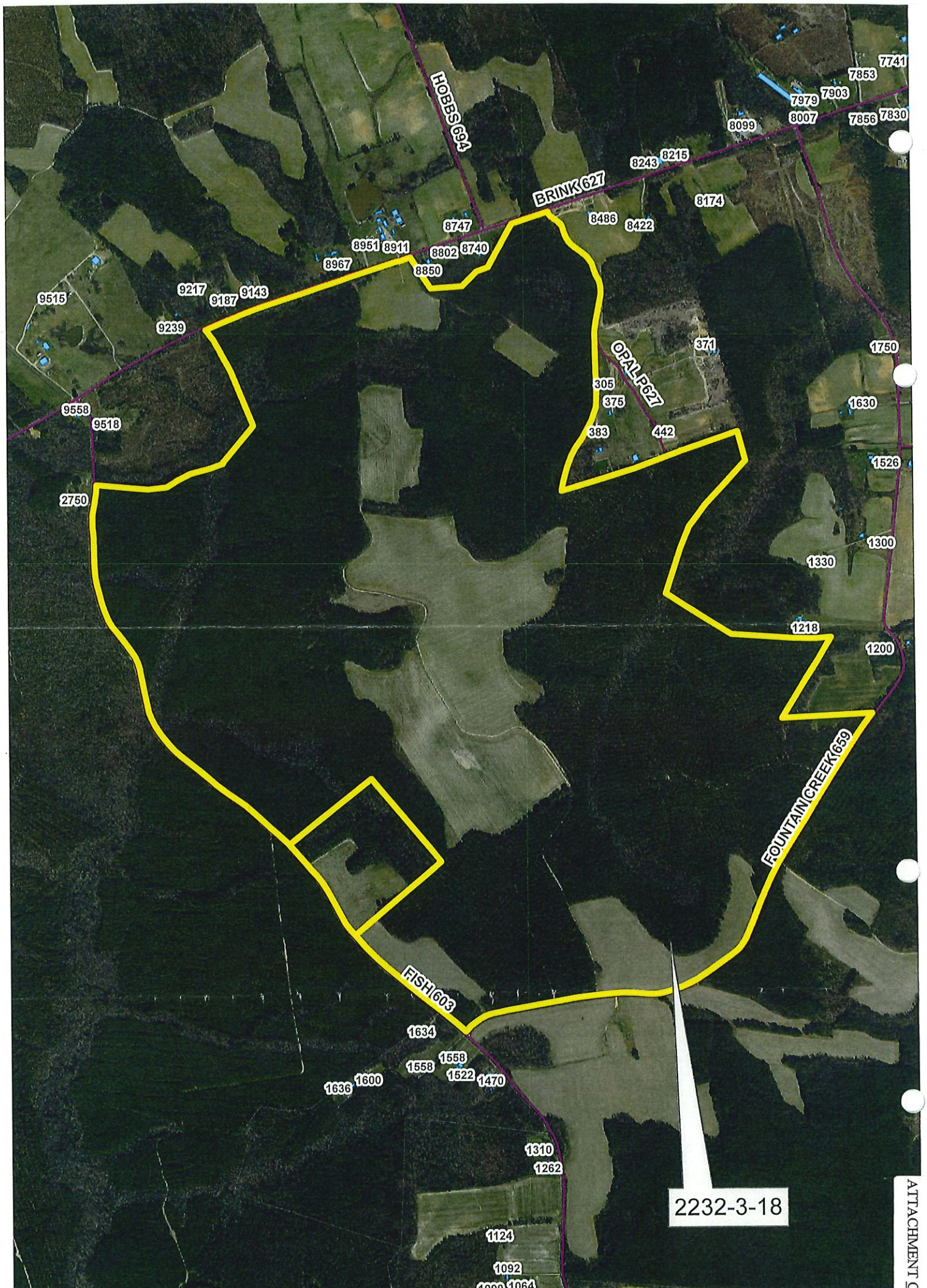
I move that the Fountain Creek Solar, LLC's proposed 80-megawatt photovoltaic solar energy facility as described in 2232 Review application 2232-3-18, is not substantially in accord with the Greensville County Comprehensive Plan or parts thereof for the following reasons:

1. The Comprehensive Plan indicates that solar energy facilities may be acceptable if not detrimental to surrounding areas. The proposed solar energy facility increases the concentration of land approved for solar use to a point that does not preserve the rural character of the County.
2. The proposed solar energy facility's 2.2 mile transmission line cannot incorporate sufficient buffers to address the impacts on adjacent areas.
3. The application property is designated in the future land use plan as Rural Residential and is planned for agricultural and farming uses and the solar energy facility is inconsistent with this designation.
4. The proposed solar energy facility will occupy 802 acres of agricultural/forestal land.
5. Concern regarding the decommissioning of the proposed solar energy facility, such as, financial assurance that facility will be removed and restoration of the application property to its agricultural uses. Without proper decommissioning the application property may not be suitable for agricultural purposes after the proposed solar energy facility has completed its useful life.

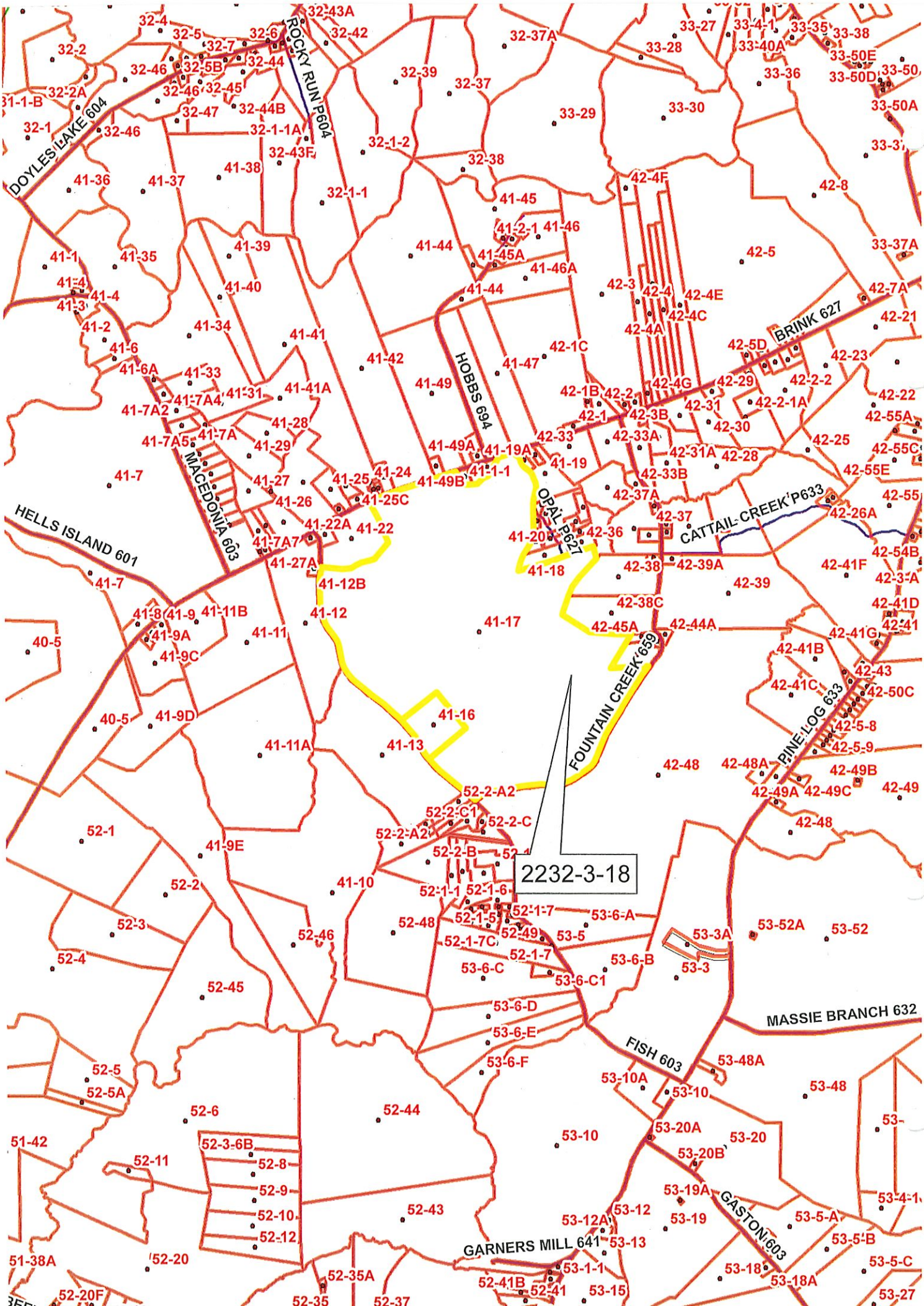
The Secretary of the Planning Commission is directed to communicate the Planning Commission's findings to the Board of Supervisors.

Option 3 – Deferral of the application

I move that the Planning Commission defer a decision on Fountain Creek Solar, LLC's request under Va. Code § 15.2-2232 regarding its proposed 80-megawatt photovoltaic solar energy facility as described in 2232 Review application 2232-3-18, until the Planning Commission meeting scheduled to begin at ____ p.m. on _____, in the Board of Supervisors meeting room.



ATTACHMENT C


2232-3-18
ROCKY RUN P604
DOYLES LAKE 604
HELLS ISLAND 601
MACEDONIA 603
HOBBS 694
OPAL P627
FOUNTAIN CREEK 659
CATTAIL CREEK P633
BRINK 627
PINE LOG 633
MASSIE BRANCH 632
FISH 603
GASTON 603
GARNERS MILL 641

41-17, 42-48	PENDER L SMITH, JR, ALFRED SMITH & ALICE S. BIVENS LIFE ESTATES C/O PATRICIA B CLARY 405 LAUREL STREET EMPORIA, VA 23847
41-16	TREDWAY AND BLAKE LLC, C/O ELIZABETH B FERGUSON 3903 ROCK BRIDGE ROAD SKIPPERS, VA 23847
42-49	JAMES S FERGUSON, JR 1091 BRINK ROAD EMPORIA, VA 23847
42-50	JAMES S. FERGUSON, JR & SHEILA B FERGUSON 1570 BRINK ROAD EMPORIA, VA 23847
42-53	LINDA W. SMITH AND SANDY M WEBB C/O LINDA W SMITH 409 PINECREST AVENUE ROANOKE RAPIDS, NC 27870
42-3-A	CHARLES ROBERTS JR. OR SUSIE S ROBERTS 1290 PINE LOG ROAD SKIPPERS, VA 23879
42-54	SMITHFIELD-CARROLL'S FARMS MURPHY-BROWN, LLC P. O. BOX 856 WARSAW, NC 28398

Tax Map #	Land Owner
41-22, 41-22A	S. DELACY & VIRGIE EASTER STITH 4525 MIARFIELD ARC CHESAPEAKE, VA 23321
41-12A	MAGNOLIA P ALLEN – LIFE ESTATE 9558 BRINK RD EMPORIA VA 23847
41-12	E H POWELL ESTATE & OTHERS C/O CORA POWELL GILES 9055 SAND BRIDGE ROAD HOPEWELL, VA 23860
41-12B	JONATHAN TYRONE ADAMS – LIFE ESTATE 4466 BRYTER DRIVE DOUGLASVILLE, GA 30135
41-13	ERIE FOREST INVESTMENTS LLC 15 PIEDMONT CENTER, STE. 1250 ATLANTA, GA 30305
52-2-A2	CAROL YVONNE WEBB 1523 NORRIS STREET CAMDEN, NJ 08104
52-2-A1A	DOROTHY I ROSS – LIFE ESTATE-AT DEATH-THOMAS E ROSS,SR 7729 BELMONT STAKES DRIVE MIDLOTHIAN, VA 23112
52-2-A1B	SHEILA ROOK HUDNELL OR DIND D ROOKS DIMPS 9107 SHERWOOD FOREST WAY UPPER MARLBORO, MD 20772
52-2-A1C	DEBORAH AND SHIRLEY GILLUS 1522 FISH ROAD EMPORIA, VA 23847
52-2-C1	SANDRA SMITH 1434 FISH ROAD EMPORIA, VA 23847
52-2-C,52-2-B	WANDETTE V HATTLEY OR BERKLEY M ROYSTER OR UZILL R WEAVER 1000 BRIGHTSEAT ROAD #456 HYATTSVILL, MD 20785
52-1-3	MAUREEN C. BARNARD, LEROY GARY JR. & OTHERS 1504 ROWLAND STREET BRONX, NY 10461
52-1-4	LEAH R RAMSEY C/O MARSHALL R. RAMSEY 922 THORNBRIAR COURT HAMPTON, VA 23661
52-1-2B	SHIRLEY RAWLES JAMES 7717 ORANGE TREE COURT CAPITOL HEIGHTS, MD 20743
52-1-6	ELLEN ANN RAWLES 1092 FISH ROAD EMPORIA, VA 23847
52-1-6E	DESSERY R GREEN 2822 SCHLEY AVE APT. 4C BRONX, NY 10465

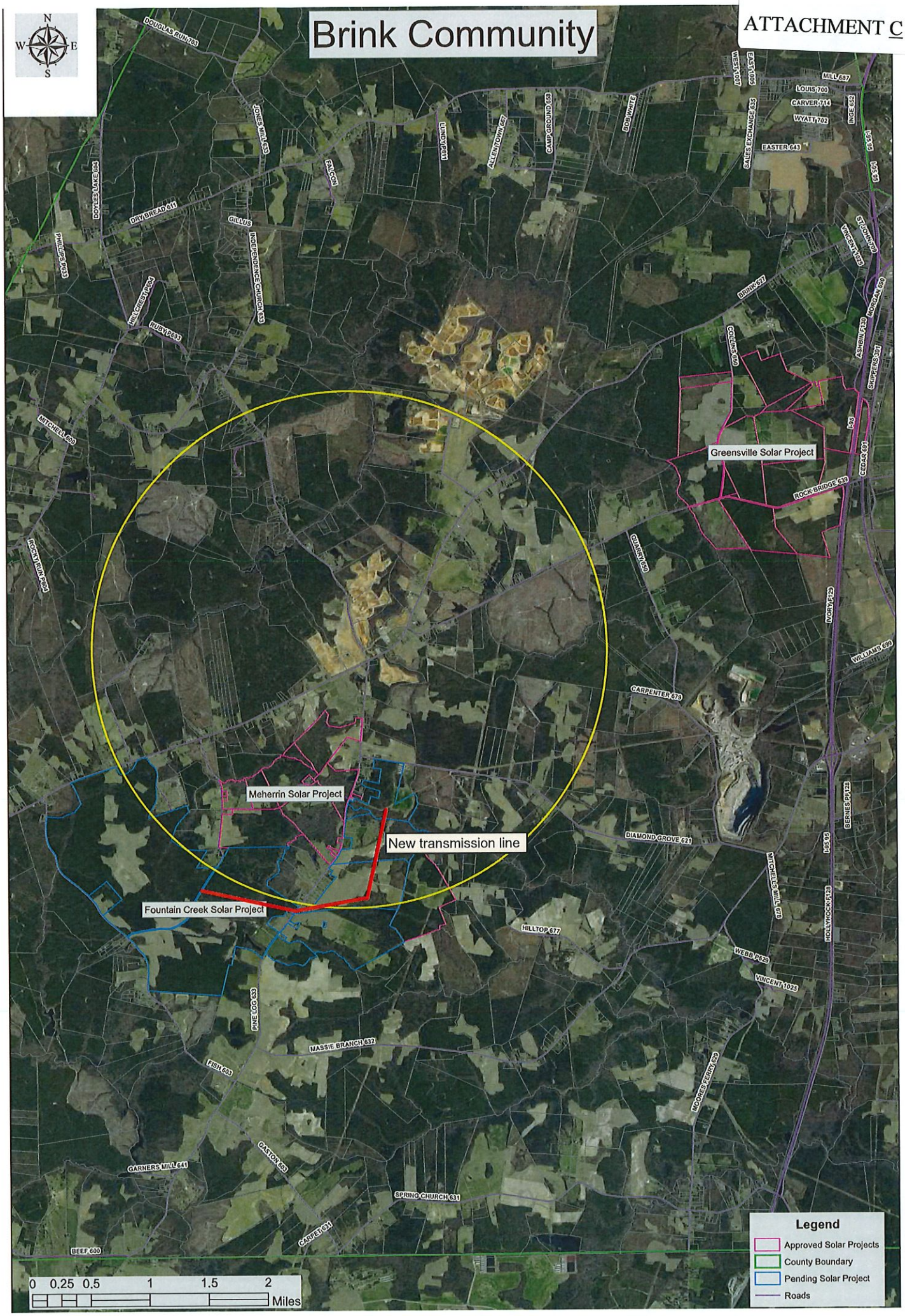
53-6-A	ELAXANDER ROOK 1700 IVEY STREET ROANOKE RAPIDS, NC 27870
53-3	GEORGE B LIGON SR & ALICE R LIGON TRUSTEES C/O G B LIGON, JR. 11906 EAGLE PASS DRIVE CHESTERFIELD, VA 23838
42-44A, 42-44B	ERIC N HICKS 1171 FOUNTAIN CREEK ROAD EMPORIA, VA 23847
42-45	LINDA D ROOK, SHIELA D ROOK, ANGELA L ROOK & SHERYL D SPRING C/O CHERYL STEVENS 6348 BLOSSOM VIEW LANE RICHMOND, VA 23231
42-45A	JOHN EDWARD HICKS 1200 FOUNTAIN CREEK ROAD EMPORIA, VA 23847
42-38,42-38B	JERRY W ALLEN SR OR LOIS P ALLEN 1218 FOUNTAIN CREEK ROAD EMPORIA, VA 23847
42-38C	TIMOTHY PRICE PEARSON 1412 HAMILTON STREET ROANOKE RAPIDS, NC 27870
42-37E	THE LEE-HUTCHESON FAMILY LIMITED PARTNERSHIP 1075 LYNN COURT ALEXANDRIA, VA 22302
42-36,41-18,41-20A	PHILLIP L BROWN 298 OPAL STREET EMPORIA, VA 23847
41-21	LINWOOD L BROWN 383 OPAL STREET EMPORIA, VA 23847
41-20	LUCINDA BROWN 305 OPAL STREET EMPORIA, VA 23847
41-19	TIMOTHY W PHELPS C/O JAMES R BROWN 371 OPAL STREET EMPORIA, VA 23847
41-19B	JOYCE D TURNER 803 PEACHTREE STREET EMPORIA, VA 23847
41-19A	JAMES R. BROWN REVOCABLE TRUST 371 OPAL STREET EMPORIA, VA 23847
41-47	LLOYD E. BENNETT 3435 TRIPLET ROAD TRIPLET, VA 23868
41-48	BEN J POWELL ESTATE C/O JOYCE D TURNER 803 PEACHTREET STREET EMPORIA, VA 23847
41-1-2B	ANGEL D ALLEN 8740 BRINK ROAD EMPORIA, VA 23847
41-1-2A	PENNY W POWELL

	8802 BRINK ROAD EMPORIA, VA 23847
41-1-1	EDDIE J WRIGHT JR & MAXINE W COPELAND 8850 BRINK ROAD EMPORIA, VA 23847
41-49A,41-49C	KENNY W POWELL 28407 GRIZZARD ROAD EMPORIA, VA 23847
41-49	LINDA W SMITH & ANGEL D ALLEN C/O ANGEL D ALLEN 8951 BRINK ROAD EMPORIA, VA 23847
41-49B	ANGEL D POWELL OR CHRISTOPHER N ALLEN 8951 BRINK ROAD EMPORIA, VA 23847
41-42	EDDIE PAIR ESTATE C/O BERNARD PAIR 8967 BRINK ROAD EMPORIA, VA 23847
41-43	ALVIN B PAIR, JR. P. O. BOX 822 EMPORIA, VA 23847
41-24A	DOROTHY A HICKS 9187 BRINK ROAD EMPORIA, VA 23847
41-24B	Myles W. Bostic Jr. Trustee Myles W. Bostic Jr. Living Trust 933 Poplar Avenue Chesapeake, VA 23323
41-24, 41-41	Ronnie Louise Roberts or Carolene Yvette Skeeter 105-25 Farmers Blvd Saint Albans, NY 11412
41-25C	WILLIAM C BOWSER SR. OR BARBARA M BOWSER 9239 BRINK ROAD EMPORIA, VA 23847
42-43C	TRUST OF FOREST HILL BAPTIST CHURCH 2103 PINE LOG ROAD SKIPPERS, VA 23879
42-48A, 42-48B	GEORGE L THORPE 34666 MONROE ROAD NEWSOMS, VA 23874
42-49C	CHESTER V VAUGHT OR DIANE R VAUGHT 2342 PINE LOG ROAD SKIPPERS, VA 23879
42-49A	TODD B ALLEN OR KRISTIE P ALLEN 2494 PINE LOG ROAD SKIPPERS, VA 23879
53-52	CARSON E SAUNDERS, JR. TRUSTEE OF KATHLEEN R LIGON REVOCABLE TRUST C/O SCOTT THOMPSON 204 SOUTH MAIN STREET EMPORIA, VA 23847
42-49B	CEDRIC L FERGUSON OR MABEL B FERGUSON C/O SONEE FERGUSON HASTY P. O. BOX 457 JACKSON, NC 27845
53-54, 53-55	MASSIE BRANCH FARM LLC 358 HILLTOP LANE SKIPPERS, VA 23879
53-53	WILLIAM R DOGGETT OR LISA P DOGGETT 733 YORKTOWN ROAD POQUOSON, VA 23662

42-51	JAMES S FERGUSON, SHEILA B FERGUSON & JAMES S FERGUSON, JR 1570 BRINK ROAD EMPORIA, VA 23847
42-5-11	TAMARA R JACKSON 2280 PINE LOG ROAD SKIPPERS, VA 23879
42-5-10	ANTHONY M PERNELL 2180 PINE LOG ROAD SKIPPERS, VA 23879
42-5-9	DENNIS A WILLIAMS OR LESLIE E WILLIAMS 2060 PINE LOG ROAD SKIPPERS, VA 23879
42-5-8	ALONZA MAURICE MASON 2020 PINE LOG ROAD SKIPPERS, VA 23879
42-5-7	CHARLES B NUNNALLY OR KIMBERLY NUNNALLY P. O. BOX 388 EMPORIA, VA 23847
42-5-6	DAVID L DAVIS P. O. BOX 562 EMPORIA, VA 23847
42-5-5	ERNEST A ROYAL OR KIMBERLY KAYE ROYAL 1984 PINE LOG ROAD SKIPPERS, VA 23879
42-5-4	DELLA PALMER GOLDSBERRY P. O. BOX 842 EMPORIA, VA 23847
42-5-3	ANDREA S HINES 1966 PINE LOG ROAD SKIPPERS, VA 23879
42-5-2	HARBOUR PORTFOLIO VIII LP 8214 WESTCHESTER SUITE 635 DALLAS, TX 75225
42-5-1	JEFFERY BOZARD 1936 PINE LOG ROAD SKIPPERS, VA 23879
42-50C	CHERFONDA R LEE 1900 PINE LOG ROAD SKIPPERS, VA 23879
42-50B,42-50D	JAMES E TOMLINSON, JR 54 SHEARIN ST EMPORIA, VA 23847
42-50A	HARDING A TRAVIS JR 1810 PINE LOG ROAD SKIPPERS, VA 23879
42-42,42-42A	FOREST HILL BAPTIST CHURCH TRUSTEES 2103 PINE LOG ROAD SKIPPERS, VA 23879
42-41C	LESLIE W MOSELEY OR DEBBIE F MOSELEY 1969 PINE LOG ROAD SKIPPERS, VA 23879
42-41C1	KIRK W MOSELEY OR ERICA P MOSELEY 1969 PINE LOG ROAD SKIPPERS, VA 23879
42-41B	JAMES R GORDON JR OR KATHLEEN H GORDON 1163 SKIPPERS ROAD EMPORIA, VA 23847

42-43, 42-41E1	RUBY G JONES LIFE ESTATE – AT DEATH RUBETTE LANE JONES & OTHERS 1863 PINE LOG ROAD SKIPPERS, VA 23879
42-41E, 42-41E	ALAMANCE JONES JR OR CONNIE T JONES 1801 PINE LOG ROAD SKIPPERS, VA 23879
42-41F, 42-41	DANE L LITTLE OR KELLIE B LITTLE 4171 BRINK RD EMPORIA, VA 23847
42-41G	LINDA L PAULSON 1735 PINE LOG RD SKIPPERS, VA 23879
42-40, 42-41D	ALICIA FRENCH 1491 PINE LOG RD SKIPPERS, VA 23879
42-53A1	A G GORDON ESTATE PINE LOG ROAD SKIPPERS, VA 23879
42-53A	F J DAUGHTREY, JR. OR JUDY ARLENE WRENN 1500 PINE LOG ROAD SKIPPERS, VA 23879
42-52	CHARLES RANDOLPH GARRIS 711 DIAMOND GROVE ROAD SKIPPERS, VA 23879
43-42	DONALD M DRIVER & J. RODNEY DRIVER C/O J. RODNEY DRIVER 750 PINE LOG ROAD SKIPPERS, VA 23879
43-3C	JIMMIE L. CURRIN JR. 4840 THORNWOOD AVENUE PORTSMOUTH, VA 23703
42-54C	SMITHFIELD-CARROLL'S FARMS MURPHY-BROWN, LLC P. O. BOX 856 WARSAW, NC 28398
42-54I	DAVID J OR GLENDA D CREATH 914 PINE LOG ROAD SKIPPERS, VA 23879
42-54D	BETTY LOUISE BRADLEY GORDON, LIFE ESTATE AT DEATH REMAINDER TO HER CHILDREN 3002 DIAMOND GROVE ROAD SKIPPERS, VA 23879
42B—3-8, 42B-3-9	LYMAN ALLEN OR KATHIE W LITTLE 998 PINE LOG ROAD SKIPPERS, VA 23879
42B-3-10, 42B-4-12	HAYWOOD D OR MARTHA E JONES 1058 PINE LOG ROAD SKIPPERS, VA 23879
42-55	WILLIS MICHAEL DRIVER 5351 BROAD STREET ROAD LOUISA, VA 23093
42-54A	JAMES RODNEY DRIVER 750 PINE LOG ROAD SKIPPERS, VA 23879
42-54A2	DONALD MITCHELL DRIVER 18 DALTON CT ROANOKE RAPIDS, NC 27870

ATTACHMENT C



ATTACHMENT C

GREENSVILLE COUNTY, VIRGINIA

APPLICATION FOR DETERMINATION PURSUANT TO VIRGINIA STATE CODE §15.2-2232

1. APPLICANT (Company or Agency): Fountain Creek Solar, LLC
2. APPLICANT'S MAILING ADDRESS: 100 California Street, Suite 400, San Francisco, CA 94111
3. TELEPHONE NUMBER: 415-627-4656 EMAIL: aarty.joshi@clearwayenergy.com
4. REPRESENTATIVE/AGENT NAME: Aarty Joshi / David Stoner
5. REPRESENTATIVE/AGENT'S MAILING ADDRESS: 100 California Street, Suite 400 San Francisco, CA 94111
6. REPRESENTATIVE'S TELEPHONE NUMBER: 415-627-4656 434-227-2105 EMAIL: aarty.joshi@clearwayenergy.com davidastoner1@gmail.com
7. LOCATION OF PROPERTY (Common description if no street address): Project boundaries adjacent to Brink Road, Fish Road, and Fountain Creek Road.
8. ZONING DISTRICT: A-1
9. COMPREHENSIVE PLAN DESIGNATION: Agricultural, Forestry, Fishing, and Hunting
10. TAX MAX NUMBER (S): 41-16, 41-17
11. SIZE OF PARCEL (S) (ACERAGE): 25 AC, 777.27 AC
12. ACREAGE PROPOSED FOR PROPOSED USE: 25 AC, 777.27 AC
13. PROPERTY OWNER INFORMATION (IF OTHER THAN APPLICANT):
    a. OWNER'S NAME: 41-16: TREDWAY AND BLAKE LLC C/O ELIZABETH B FERGUSON 41-17: SMITH PENDER L JR ALFRED SMITH & ALICE S BIVENS
    b. OWNER'S MAILING ADDRESS: 41-16: 3903 ROCK BRIDGE RD. SKIPPERS, VA 23879 41-17: 405 LAUREL ST. EMPORIA, VA 23847
    c. Has the Property Owner been contacted about this proposed use? YES X NO

14. DESCRIPTION OF PROPOSED USE/REASON FOR REQUEST: _____

Allow the use of a utility-scale solar power electrical generation facility on 802-acres within the existing A-1 zoning.

_____ (attach additional sheets if necessary)

15. PRIOR ZONING APPROVALS: None

16. SUPPORTING MATERIALS AND INFORMATION (attach additional sheets):

a. Fee of $ 775.00 payable to "Greensville County"
b. Proposed use drawing/site plan- may be submitted as 11" x 17".
c. List of adjoining property owners to include names and addresses.
d. Comprehensive Plan policies and guidelines that directly support the proposed use.
e. Alternative sites considered for the proposed use.
f. Anticipated impacts and mitigation measures proposed.
g. Photographs of any existing structures, buildings, and property, as applicable.

APPLICANT'S SIGNATURE

I, the undersigned, certify that this application is complete, accurate and contains all required and requested information, documents and other submittals and that all statements made herein are, to the best of my knowledge, true and correct. The undersigned acknowledges that additional review requirements may be identified during the review of this application. The undersigned also acknowledges that all Greensville County Zoning Ordinance requirements pertaining to the proposed use must be fulfilled.

I, undersigned, understand that the cost incurred by the County to retain independent consultants to review the application and any other associated documents is my responsibility and agree to pay when billed by the County. I agree to pay all additional advertising costs for continuances and appeals.

10/2/2018
DATE

SIGNATURE OF APPLICANT

Submit FOURTEEN (14) sets of completed application, fee, and supporting materials to:

Director of Planning, 1781 Greensville County, Emporia, Virginia 23847 (by mail)
Or by hand at the Building and Planning Department in Greensville County Government Building at 1781 Greensville County Circle, Emporia, Virginia, 23847. Phone (434)348-4232.

Incomplete applications will not be processed. The applicant will be notified of any deficiencies. Any revisions to the application that require replacement of pages or plans is the responsibility of the applicant. Any questions should be directed to the Director of Planning.

RECEIVED
OCT 10 2018
GREENSVILLE COUNTY
BUILDING & PLANNING

ATTACHMENT C

2232 APPLICATION NARRATIVE

FOUNTAIN CREEK SOLAR PROJECT
BRINK ROAD
GREENSVILLE COUNTY, VA

PREPARED FOR:
FOUNTAIN CREEK SOLAR, LLC
A subsidiary of
CLEARWAY ENERGY GROUP, LLC
100 CALIFORNIA STREET, SUITE 400
SAN FRANCISCO, CA 94111

PREPARED BY:
KIMLEY-HORN AND ASSOCIATES, INC.
421 FAYETTEVILLE STREET, SUITE 600
RALEIGH, NORTH CAROLINA 27601

OCTOBER 8, 2018

KHA #017261003

Table of Contents

Appendices

Section I – Introduction

Project Overview

Fountain Creek Solar, LLC, a subsidiary of Clearway Energy Group, LLC (Clearway) plans to construct and operate the Fountain Creek Solar Project (Project), a photovoltaic solar electrical generation facility with a capacity of up to 80 megawatts (MW) on a site of approximately 802 acres located approximately 8 miles southwest of Emporia in Greensville County, Virginia. The existing site is used for agriculture and timber growing and consists of fields, farm paths, wooded areas, and natural wetlands (see Attachment A for existing site photos). When fully constructed, the facility will supply approximately 16,000 Virginia households with clean, renewable energy. An approximately 2.2 mile interconnection transmission line will convey the power produced at the project to the existing grid through an interconnection point east of the Mecklenburg Electric Cooperative's Brink Substation that is located along Pine Log Road.

Land for the project will be leased from existing property owners, which is typical for this type of development and preferred by the landowners. Including extensions, the lease term of the land agreements is 40 years. It should be noted that a small section of the interconnection transmission line and the interconnection switchyard will be purchased in fee, pursuant to existing purchase option agreements. These two parcels will require subdivision pursuant to Greensville County rules and regulations. This structure provides a mutually agreeable set of lease terms and a very stable and steady income for the landowner. A decommissioning plan will be implemented at the end of the Project life, and is discussed in Section II.

County Process

There are two main County approvals required for this project:

1. **Section 15.2-2232 Review Application – Greensville County**

The process to ensure that the general location, character, and extent of the proposed Fountain Creek Solar Project site is in accordance with the adopted Greensville County Comprehensive plan or part thereof, as per Virginia State Code Section 15.2-2232. This narrative is intended to provide additional project information to support this Section 15.2-2232 review. The site has been carefully selected as suitable for this purpose. The site is compatible with and not detrimental to the rural nature of the surrounding area.

2. **Special Use Permit – Greensville County**

Special Use Permits (SUP) are permits authorized by the Board of Supervisors for a use designated as a "special use" in a designated district after evaluation of the potential impact and compatibility of such use. Fountain Creek will be requesting approval for a SUP from Greensville County after the 2232 review.

Development Process

In addition to the 2232 and SUP submittals to Greensville County, the following two approvals and permits, plus supporting review processes will be required for this project:

Interconnection Agreement – Dominion Virginia Power

The project requires an agreement with PJM Interconnection, LLC ("PJM") and Dominion Virginia Power (DVP) to interconnect into the electrical power distribution network. Independent transmission evaluations were conducted prior to selecting the site to confirm that the location was optimal for supplying power to the grid. Additionally, PJM has conducted extensive studies to ensure the suitability and determine the design of this interconnection.

The project executed an Interconnection Service Agreement and Interconnection Construction Service Agreement with PJM Interconnection, LLC and Dominion Electric and Power Company in August 2018 to interconnect into the electrical power transmission network. Therefore, the interconnection study process is complete.

Renewable Energy "Permit By Rule" – Commonwealth of Virginia

The Permit by Rule (PBR) review and approval process is administered by the Virginia Department of Environmental Quality (DEQ). In keeping with this process, the Fountain Creek Solar Project will be meeting with the DEQ and the application will undergo review by several state agencies, including the Department of Game and Inland Fisheries (DGIF), the Department of Conservation and Recreation (DCR), the Department of Historic Resources (DHR) and Department of Mines Minerals and Energy (DMME) to ensure the project minimizes impacts to protected resources and complies with all requirements of the PBR. The Project has also performed wetlands studies to ensure compliance with US Army Corps of Engineers requirements. A number of environmental, historical/archaeological, and other studies have been or will be performed in support of these primary approvals and are described in more detail below in Section IV.

Section II – Project Description

Clearway Background

Fountain Creek Solar, LLC, a subsidiary of Clearway Energy Group, LLC is accelerating the world's transformation to a clean energy future. Built for 21st century energy markets and focused on providing customers with the power they need and the customer experience they deserve, Clearway was created and staffed with functions specific to renewable energy generation and distribution. With assets across 28 states, more than 500 employees and the capacity to power about 2.7 million homes, Clearway is bringing reliable and clean power to market from day one. The Company is headquartered in San Francisco, CA with offices in Carlsbad, CA; Scottsdale, AZ; Houston, TX; and New York City, NY. More information can be found on Clearway's website at: www.clearwayenergygroup.com

Project Description

The subject property is located on Brink Road (State Rte. 627) bound by Fish Road, Fountain Creek Road (State Rte. 659), and adjacent farmland in Greensville County, Virginia. The project site consists of two parcels which are zoned as Agricultural District (A-1). According to the Greensville County Zoning Ordinance (Table 4-1), Electric Generating Facilities may be developed on land zoned A-1 after obtaining a Special Use Permit (SUP).

Based on the proposed layout (see Attachment C Preliminary Site Plan), the project footprint is approximately 595 acres. Upon completion, the project will include the following key components:

- Ground-mounted arrays of photovoltaic panels that are typically up to 10-ft high, but can be up to a max of 15 feet in height, arranged in rows, spaced approximately 15'-25' apart, and mounted on either fixed-tilt racking or single-axis trackers;
- Project substation to be constructed on the southeastern border of the solar array and include breakers, main step-up transformer, metering and communications equipment, and buswork. The footprint of the on-site substation would be approximately 200-feet by 200-feet with potential components up to 75 feet high;
- Approximately 2.2 miles of 115kV overhead electrical transmission line constructed with either monopole or H-frame design of approximately 60-70' foot tall poles; Anticipated path of the transmission line is shown on the Preliminary Site Plan;
- Interconnection switchyard connecting the project transmission line to the existing Dominion 115kV transmission line, just east of the Mecklenburg Co-op Substation
- Communication and Supervisory Control and Data Acquisition Facility Control Systems;
- Inverters, combiners, and transformers;
- Buried and above-ground electrical conduits;
- Onsite unpaved access roads, consisting of 16-foot-wide interior perimeter access roads and 8- to 12-foot-wide interior access paths;
- Chain link security fencing, up to 6 feet in height with an additional 1-ft of barbed wire, located along the site perimeter, with locked gated entrances;
- Setbacks from County road right-of-ways or adjoining properties of 150' to PV or substation equipment, to include a 50' minimum existing or planted vegetative buffer to screen project from adjoining properties;
- A prefabricated container-sized O&M storage shed;
- Gravel-surfaced access driveways fronting onto Brink Road, Fountain Creek Road, and Fish Road; and
- Low-elevation security lighting at the on-site substation and the O&M building/container.

The project will be connected to Dominion's transmission system via an approximately 2.2-mile 115kV interconnection line, extending from the project substation on the project site, to a new interconnection switchyard located along the existing Dominion 115kV line feeding the Brink substation, as shown in the Preliminary Site Plan in Attachment C. The interconnection line will be similar to the existing Dominion 115 kV line serving the existing Mecklenburg Co-op substation. It will be constructed of either wood or steel, single-pole or H-frame design, with poles approximately 60-70' in height, and spaced at approximately 300-600' along the route. See the Preliminary Site Plan within Attachment C for a representative depiction of the interconnection alignment. The transmission line route was selected to run primarily through existing wooded areas, or behind existing vegetative screens where possible to minimize views of the line. Where the interconnection line route must cross existing agricultural fields, pole locations will be coordinated with land owners to minimize impact to existing farming operations.

Environmental features such as wetlands will be avoided or spanned in order to prevent impacts whenever possible. The anticipated transmission line route will be up to a 150-ft cleared pathway. The final location of this route may shift from what is shown on the Preliminary Site Plan within Attachment C based upon the outcome of the environmental surveys which will be completed along the proposed route.

The interconnection line will terminate at a new interconnection switchyard on an approximately 2-acre parcel. The interconnection switchyard will be approximately 200'x200' in dimension, fenced, and include transmission structures not exceeding 75' in height, breakers, and ancillary equipment. See the Preliminary Site Plan within Attachment C for a representative depiction of the interconnection switchyard location. The interconnection switchyard will be located in an area largely not visible from County road right-of-ways, due to topography and existing woodlands.

Decommissioning Plan

The purpose of the Decommissioning Plan is to ensure proper removal of associated components of the project and restoration of the site to pre-existing conditions and to estimate the costs associated with decommissioning of the project at the end of operations. Decommissioning and restoration of the facility site will commence at the end of the facility's natural life, which is expected to be 40 years. The Fountain Creek Solar Project will be responsible for decommissioning and restoring the site; the general decommissioning approach will be the same whether a portion of or the entire facility is decommissioned.

The individual facility components to be decommissioned will be recycled to the maximum extent practical. Electrical equipment including inverters, transformers, cables, electrical lines, and switchyard infrastructure will be decommissioned in accordance with local, state, and federal laws and all required permits will be obtained, as needed. The Decommissioning Plan will also be completed in accordance with the landowner agreements.

A proposed decommissioning plan will be submitted with the SUP application for the County's review.

Section III – Project Benefits

The Fountain Creek Solar Project will bring a number of benefits to Greensville County and to Virginia. These many benefits include:

Jobs

- Approximately 100-175 construction jobs will be created over the 12-month construction timeline.
- The facility will employ 1-3 permanent operational personnel, plus additional contractors for operations and maintenance.

Revenue Generation and Economic Benefits

- Initial property tax revenue for the County estimated at $115,000 per year, or net of $85,000 per year (considering potential composite index changes), with a lifetime net NPV of property tax revenue of over $1.1 million to the County.

- Construction and operation of the project will generate labor income, economic development for regional businesses, including engineering and construction, consulting, landscaping, and hospitality firms. This "ripple" economic effect in Greensville County is estimated at over $14 million during construction and over $350,000 annually during operations, and almost double that statewide for Virginia.
- The project will be a source of state and local sales tax for in the County ($400,000) and statewide in Virginia ($950,000), direct and indirect, during construction, plus additional sales tax revenues during operations.
- Additional details on economic impact of the project is quantified in the report entitled Mangum Economics, "The Economic and Fiscal Contribution That The Brink Solar Project *(Fountain Creek Solar Project)* Will Make to Greensville County and Virginia, November 2017" which is currently being updated and will be submitted as part of the Special Use Permit Application.

Community Benefits

- The project stimulates economic development in the County with minimal requirements for Greensville County facilities or services.
- Although the site would be developed with solar, the project offers a long-term open land preservation strategy for the county as the site could be returned to open agricultural land after decommissioning.
- Clearway will seek to educate the public about solar energy and would work cooperatively with schools and other organizations in this manner.

Environmental Benefits

- The project will produce enough clean efficient reliable renewable power for up to 16,000 Virginia homes in the region.
- Construction of the project supports Virginia's renewable energy goals.
- The renewable energy produced will offset annual carbon dioxide emissions approximately equivalent to removing 40,000 cars from VA highways, 1000 railcars of coal, or 450 million lbs. of carbon emissions (Source: US EPA).

Section IV – Potential Impacts and Mitigation

Traffic Impacts

Potential traffic impacts will be most noticeable during construction of the project, with operational traffic impacts being negligible.

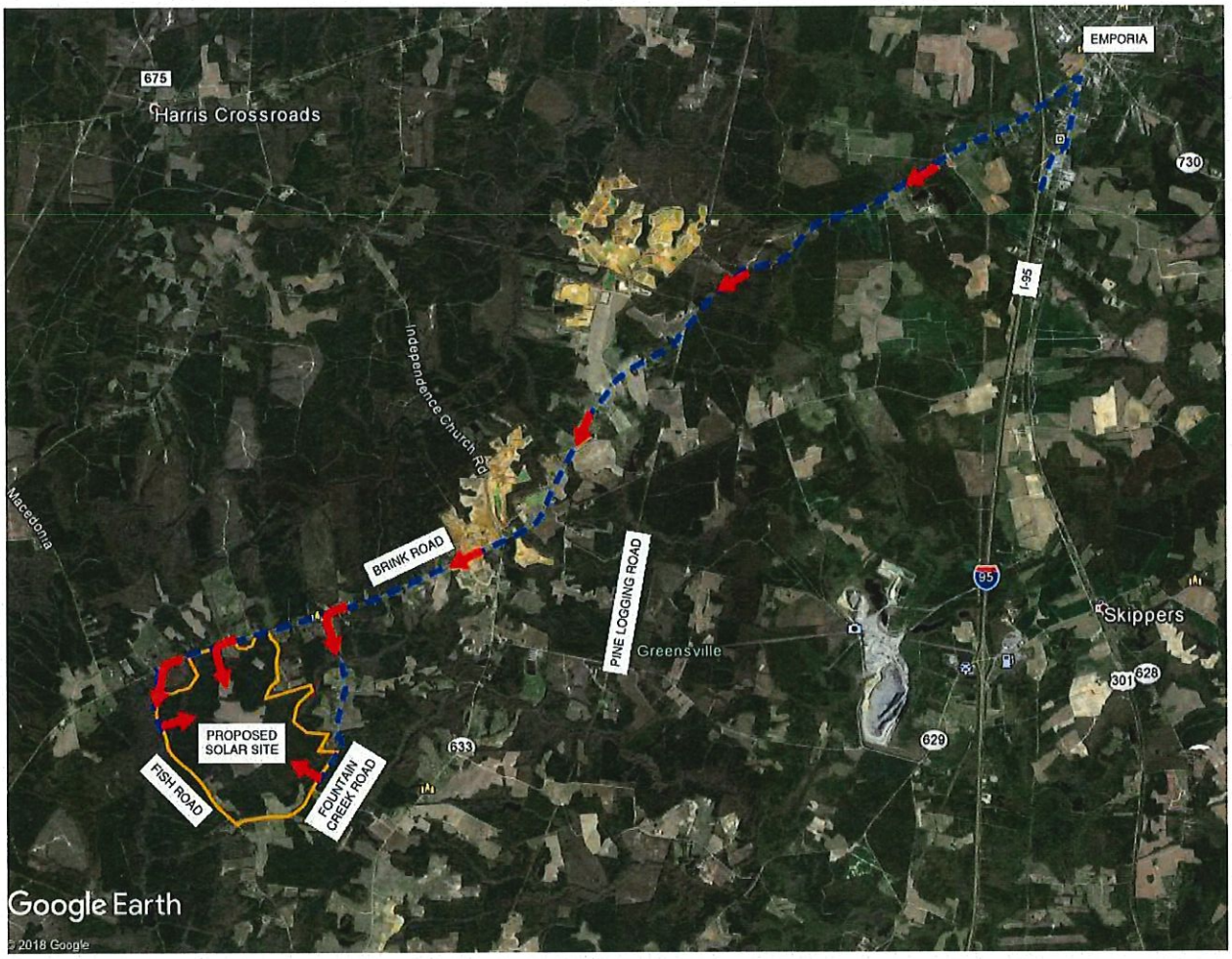
During construction, estimated to be 12 months with peak construction activities occurring over a 4-6 month period, the Fountain Creek Solar Project estimates 10 - 20 trucks per day with an occasional peak of 30 – 40 trucks per day for material deliveries during construction and an additional 2 – 4 concrete trucks depending if there is any overlapping of activities. Heavy trucks for material deliveries do not operate during the entire construction duration of the project, only during peak times. The Fountain Creek Solar

Project estimates a peak of 175 personnel being on the project site during construction with an average of 100 workers daily. Accounting for carpooling, a maximum of 300 employee vehicle trips per day are anticipated.

The majority of deliveries construction traffic will likely come off I-95, down Brink Road, and will have the following three options to access the site:

1. Turning left onto Fountain Creek Rd 659 then right into the southern entrance to the site (most traffic is anticipated here as this is the entrance to the majority of the site).
2. Turning left into the northern entrance of the site off Brink Rd (for the northern array of panels).
3. Turning left onto Fish Road and then left into the site for the panels along Fish Road.

See figure below for routes of construction traffic:



The *Greensville County Comprehensive Plan* contains an annual average daily traffic comprehensive plan prepared by K.W. Poore and Associates, Inc. in March of 2008 which indicates that the section of Brink Road along the site frontage designated as a Secondary Road experiences between 70-1300 cars as an annual average daily traffic generation. Construction traffic impacts are thus anticipated to be minimal.

During operation, the proposed solar power electrical generation facility will add only a negligible amount of additional traffic to the existing adjacent roadway infrastructure as the proposed use is a very low trip generator. Traffic activity due to periodic maintenance vehicle operations for the project will have minimal impacts and will not adversely impact either existing or anticipated future operational conditions along Brink Road. The project is expected to be monitored remotely during the operational phase of the project therefore, only occasional, on-site maintenance is expected to be required following commissioning. Initially, personnel would likely visit the Project area daily or weekly, but it is anticipated that eventually maintenance visits will be reduced to several times per month. Operations and maintenance activities will require several workers performing visual inspections, monitoring plant performance, executing minor repairs, and responding to needs for plant adjustment. On intermittent occasions, the presence of 5 to 30 workers may be required for repairs or replacement of equipment, panel cleaning, and other specialized maintenance. However, due to the self-operating nature of the facilities, such actions would likely occur infrequently anticipated to be only a few times per year.

Visual, Noise, and Light Impacts

The project site was selected due to the rural and isolated nature to minimize potential visual impacts to the community. Visual impacts of the project will be limited due to use of significant setbacks from adjacent right-of-ways, use of natural topographic buffers in site design, and application of significant existing and new vegetative buffers. The majority of the site is bounded by existing, mature vegetation (see Attachment C, Preliminary Site Plan). The project will employ setbacks from the edge of ROW and adjacent property lines of at least 150' to solar panels and substation equipment. Buffers composed of existing plant material will remain present and will provide at least 50-ft of buffering from the majority of the surrounding properties and right-of-ways; many areas will consist of existing vegetative buffer greater than 50-ft. For areas where agricultural fields border right-of-ways and limited existing buffer vegetation is present, a planted buffer 50-ft in width is proposed as shown conceptually on the Preliminary Site Plan. For this proposed buffer area, plantings composed predominantly of evergreen plant material are planned so that a continuous screen can be provided. Two visual simulations have been prepared which show a rendering of the proposed planted buffer and the existing buffer (see Attachment C, Preliminary Site Plan and Visual Simulations).

The Fountain Creek Solar Project design will include only minimal lighting. Low-elevation security lighting is proposed at the on-site substation, the off-site interconnection switchyard, and the O&M container. The lighting would only be switched on when personnel enter the area (either motion sense or manual) and would be downward-facing and directed on-site. This minimal lighting in conjunction with use of setbacks and buffers will ensure no significant offsite lighting impacts.

Solar projects are quiet and do not produce any offsite noise impacts. During construction, minimal noise will be produced due to construction traffic and intermittent onsite construction activities, but these impacts are temporary and anticipated to be minimal due to existing setbacks and buffers. Once operational, the facility will be inaudible at the site property boundary. Additionally, once operational, the facility will produce no emission or odors.

With no noise, odors, and limited visibility from adjacent properties and right-of-ways, the facility will blend into the surrounding area with minimal impact in keeping with the rural character of the area.

Land Use

Changing the land use from agricultural and timber growing to solar will replace the current legumes and row crops with meadow grass which will decrease the net stormwater runoff as a result. This decreased runoff and peak flow will provide better site stabilization and thus reduce the potential for erosion and sedimentation. Little pesticide, herbicide, and fertilizer use is anticipated for maintenance of the stabilized meadow grass land cover utilized for the solar facility and therefore, any pesticide, herbicide or fertilize use will likely be lower than the use currently required for agricultural crop production. The meadow grass mixed will be coordinated with local turf experts to determine the blend of cool season and warm season grasses that will work best for the site's location and climate.

At the end of the Fountain Creek Solar Project's natural life, the site will be returned to its pre-existing condition where it can be used once again for agriculture or timber, as per the decommissioning plan discussed in Section II. See Attachment C, Preliminary Site Plan for a summary of land use quantities for the proposed project.

A 2017 study by NC Clean Energy Technology Center is titled "Balancing Agricultural Productivity with Ground-Based Solar Photovoltaic Development" and is included as Attachment D for reference and as additional supporting documentation.

Health and Safety

No hazardous materials or petroleum products will be stored on-site. The transformers deployed for this Project may contain FR3 fluid as a coolant, which is a naturally derived ester from vegetable oils that is non-toxic, non-hazardous, environmentally safe, and is sealed in the transformers prior to delivery to the site. The transformers will be installed on impervious concrete pads.

A recent study by NC Clean Energy Technology Center stated that "...the negative health and safety impacts of utility-scale PV development were shown to be negligible, while the public health and safety benefits of installing these facilities are significant and far outweigh any negative impacts." For a detailed review of the health and safety impacts of solar facilities noted above, please see the complete study in Attachment E – *Health and Safety Impacts of Solar Photovoltaics.* Additionally, from the 2017 study included in Attachment D referenced above, it states that "There is no significant cause for concern about leaking and leaching of toxic materials from solar site infrastructure."

The Fountain Creek Solar Project will be surrounded by a perimeter fence with barbed wires with access through a single lock gate. The fence will minimize access by the public and potential for vandalism. In addition to remote monitoring, all components of the Fountain Creek Solar Project will be inspected regularly to ensure they are in proper working order. These inspections will include confirming that there is no leakage or spillage of transformer coolant.

Water and Sewer Impacts

The proposed solar power electrical generation facility will not require water or sewer service during construction or during regular operation.

A relatively small amount of water will be used during construction. Water is typically needed for dust control during construction, but given the wet climate and soils at the site, dust should not be a construction issue. Water will be needed on site for compaction purposes but will be very limited and can

be brought on site via truck. The Fountain Creek Solar Project can provide an actual estimate of water usage during the site plan permitting phase once a geotechnical study is conducted.

Due to the site's location, monthly rainfall is typically expected and cleaning of panels during the operation and maintenance phase will be minimal as the rainfall will naturally remove dust that collects on the panels. The Fountain Creek Solar Project estimates that the panels will require cleaning twice a year at most. Operations and maintenance cleaning systems functioning twice a year will use approximately 48,000 gallons of clean water annually. This relatively small amount of water can be transported on site via truck.

Environmental

County GIS data and USGS topographic mapping was used to identify the location of surrounding bodies of water. Wetlands and Waters of the U.S. (WOUS) were delineated in accordance with the methods outlined in the *U.S. Army Corps of Engineers (USACE) 1987 Wetland Delineation Manual* and *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0)*. The vast majority of wetlands are to remain undisturbed except to create a new access road to the offsite switchyard. In on-site project areas where electrical connections are proposed to cross wetlands, underground directional boring will be used to avoid impact. See Attachment C, Preliminary Site Plan for anticipated locations where minimal impacts are proposed. The Fountain Creek Solar Project will secure permits from the state and USACE for wetland impacts, if required, prior to or as part of the state Permit by Rule process.

Kimley-Horn and Associates conducted a preliminary review of readily available database and agency information regarding potential occurrences of federal and state listed threatened and endangered (T&E) species within the proposed project limits or a 2-mile radius of the proposed project area. The review consisted of obtaining an Official Species list from the US Fish and Wildlife Service (USFWS), reviewing the Department of Game and Inland Fisheries (DGIF) Virginia Fish and Wildlife Information Service (VaFWIS) and Wildlife Environmental Review Map Service (WERMS), and submittal of the project area to the Department of Conservation and Recreation (DCR) Division of Natural Heritage (DNH).

USFWS - The USFWS Official Species List, dated July 23, 2018, documented the Northern long-eared Bat *(Myotis septentrionalis) as potentially occurring within* the vicinity of the proposed project. There are no known refuges or fish hatcheries occurring within the project area. The proposed project will avoid the northern long-eared bat habitat and we do not anticipate additional coordination or confirmation with USFWS.

DGIF – The DGIF VaFWIS and WERMS databases did not identify any known occurrences of federal or state listed endangered species within the project limits (accessed July 23, 2018).

DCR – Based on DCR's comments received on June 28, 2018, a suitable habitat may exist for the Oak toad (*Anaxyrus quercicus,* G5/S2/NL/NL) and the Barking treefrog (*Hyla gratiosa*, G5/S1/NL/LT) in the northern portion of the project site. The proposed project is anticipated to avoid the Oak toad and Barking tree frog habitat. Since the habitat areas are planned to be avoided, no permitting or mitigation is anticipated. The Fountain Creek Solar Project will be submitted to DCR for review and concurrence that no further action will be required.

Historical and Archeological

As a part of the Renewable Energy "Permit By Rule" through the Commonwealth of Virginia, Applicant has performed historical and archaeological studies and the DEQ and Department of Historic Resources (DHR) will review the site and surrounding areas to ensure historical and archeological significant areas are not affected from this development. A Phase I study of the project area has been completed. The Phase I study identified two small areas within the site that have potential for listing as eligible resources in the Virginia Landmarks Register or the National Register of Historic Places (VLR/NRHP). A Phase II study is currently being completed for further investigation into these two areas that may be eligible for listing in the VLR/NRHP. Once the Phase II study is completed, this information will be submitted to the DHR and a determination will be made as to the eligibility. If eligible, then effort will be made to avoid direct impact to these areas if possible. If impacting these areas is required, then mitigation procedures will be followed as required by DHR. This coordination will be completed prior to submitting the Permit By Rule Application to VDEQ.

Rural Nature

The Fountain Creek Solar Project as outlined above, allow will have minimal impacts on the rural nature of Greensville County and the immediate area. Environmental features will be preserved and the quiet solar arrays will largely not be visible to passing drivers or neighbors around the majority of the site, and in limited areas where there is not pre-existing vegetation will additionally have limited visibility once proposed buffers are matured. The open fields on the site will be maintained and will be returned to its original condition in the future at the end of the Fountain Creek Solar Project's natural life cycle in accordance with landowner agreements.

Section V – Comprehensive Plan Compliance

Plan Description and Goals

The Greensville County Comprehensive Plan provides general goals to guide development in the County, the most important of which is properly controlling aspects of the rural development pattern in a manner that respects the overall rural nature of the county while allowing for growth in designated areas. Specific land use goals include encouraging new development that complement surrounding uses and concentrating development in appropriate locations by encouraging more efficient site design and incorporating proper buffers between differing uses. Additionally, as listed on page 29 in the 2016 amendment, solar projects greater than 20 MW are encouraged in agriculturally zoned districts if not detrimental to the surrounding area. It is also encouraged that a decommissioning plan is provided by owner of solar energy projects to ensure proper dismantling of the project.

The rural nature of the County will be preserved due to the following project attributes:

- Setbacks: A minimum 150-foot setback maintained from the edge of the solar array and substation equipment to either the adjacent street right-of-way or adjacent property lines.
- Landscape Screening: A minimum 50-foot vegetative buffer (consisting of existing trees and vegetation) will be provided. Where there is no existing vegetation or if the existing vegetation is inadequate to serve as a buffer, a triple row of trees/shrubs will be planted on approximately 10-foot centers in the 25 feet immediately adjacent to right-of-way. New plantings of trees and

shrubs shall be approximately 6 foot in height at time of planting. In addition, pine seedlings will be installed in the remaining 25 feet of the 50-foot buffer.

- Wildlife corridors: An access corridor for wildlife to navigate through the Fountain Creek Solar Project will be provided within the existing stream/wetland corridors across the site.
- Height of Structures: Solar facility structures (ground-mounted arrays of photovoltaic panels) are typically up to 10-ft high, but can be up to a max of 15 feet in height; Poles constructed for electrical lines may exceed the maximum permitted height as provided in the A1 zoning district regulations (§16-2);
- Lighting: Any on-site lighting provided for the operational phase of the Solar facility shall be dark-sky compliant, shielded away from adjacent properties, and positioned downward to minimize light spillage onto adjacent properties.
- Noise: Daytime noise will be under 67dBA during the day with no noise emissions at night.
- Site Access Ingress/Egress: Permanent access roads and parking areas will be stabilized with gravel to minimize dust and impacts to adjacent properties.

Project Compliance

The proposed Fountain Creek Solar Facility is located on land currently zoned as A-1 Agricultural District, and is not detrimental to the low-density residential and agriculture areas which surround the site as it generates minimal traffic during operation, maintains existing natural vegetative buffers, adds vegetative buffers where none currently exist on areas adjacent neighboring properties and public right-of-ways, and utilizes existing fields for low-impact renewable energy generation. Due to the change of land use from agriculture to meadow grass, a decrease in the net stormwater runoff can be expected from the pre-development to post-development condition. A decommissioning plan including security provisions will be provided as part of the SUP submittal.

Section VI – Other 2232 Supporting Materials

Project Property Owner List

A list of property owners and addresses for the proposed solar site and transmission line has been provided; see Attachment B.

A list of all property owners adjacent to the development parcels has been provided; see Attachment B.

These lists were compiled from available Greensville County GIS information.

Alternate Sites Considered

When selecting a site for solar use, many variables are considered before the site is deemed feasible. In working to identify the current site where the project is proposed, many sites throughout Greensville County and Southern Virginia were evaluated. The criteria that were used to narrow down the search options included the following:

- Proximity to existing electrical transmission lines
- Electrical demand of existing power grid

- Open land with suitable topography
- Minimal visual impacts to surrounding properties
- Amicable property owners willing to lease or sell
- Minimal environmental impacts
- Suitable site access
- Large enough site to incorporate reasonable buffers

Of all of the sites reviewed, the proposed project site achieved all of the desired criteria and is available with willing landowners for the proposed use.

ATTACHMENT A

SITE PHOTOS

Attachment A – Site Photos

Photo Location Map:

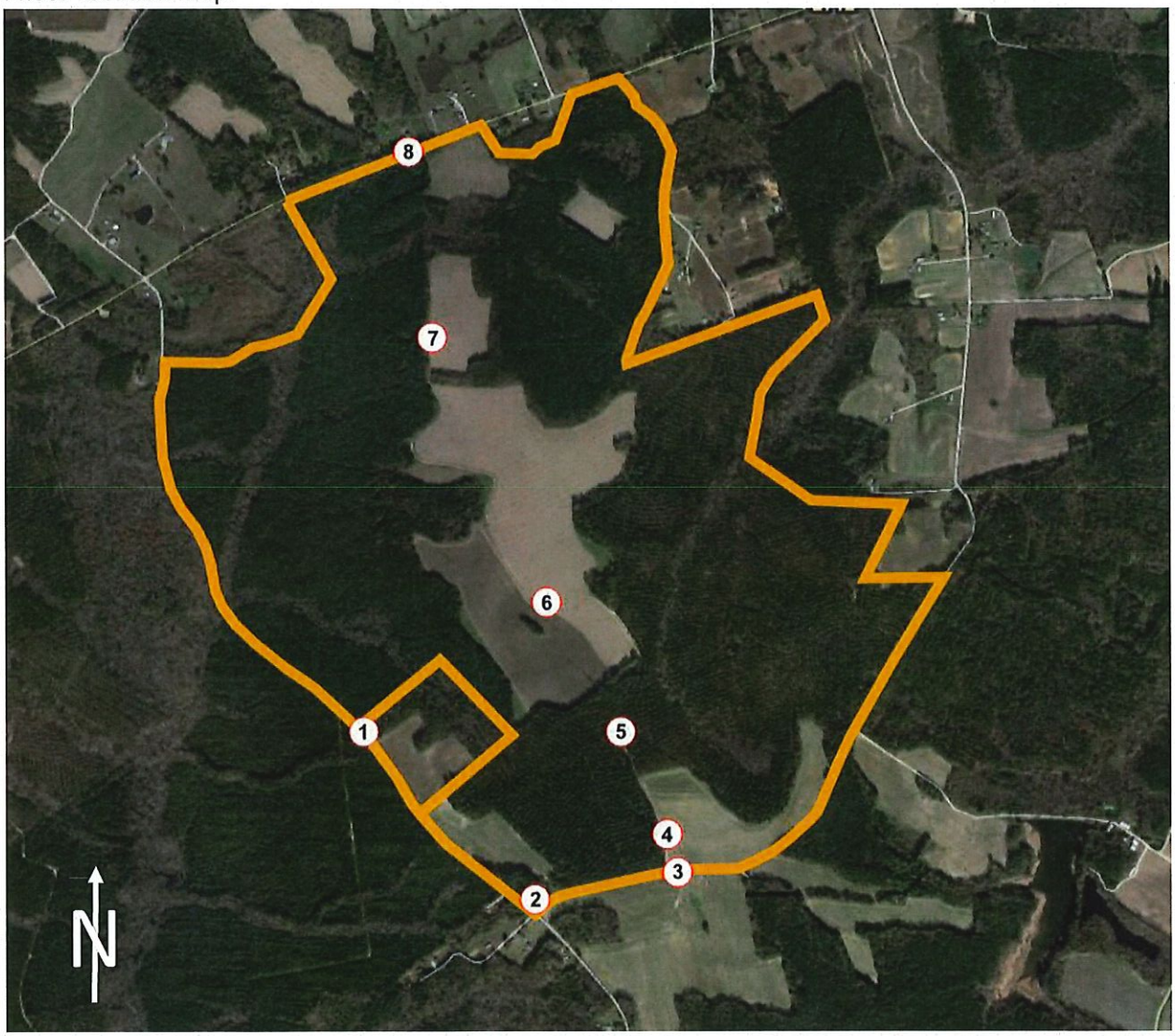


Photo 1:

Cleared farmland on parcel 41-16 looking southeast from Fish Road.

Photo 2:

Utility structure located in southwest corner of site near Fish Road & Fountain Creek Road intersection. Structure will remain in place and will not be impacted by development.

Photo 3:

Field to the south of the site looking northeast from Fountain Creek Road.

Photo 4:

Abandoned shed located along west side of field from Photo 3, north of Fountain Creek Road.

Photo 5:

Farm path connecting southern field to larger center field.

Photo 6:

Along farm path in central field looking northwest.

Photo 7:

Field to the north of the site, looking northeast from west tree line.

Photo 8:

Looking southwest down Brink Road. Drainage ditch running along side of road. Existing vegetative buffer along property line/left side of ditch.

ATTACHMENT B

PROPERTY OWNER INFORMATION

ATTACHMENT B - ADJOINING PARCELS

GPIN	MAP#	ADDRESS	NAME	MAILING ADDRESS	CITY, STATE, ZIP
7327-39-2472	41-22		S Delacy & Virgie Easter Stith	4525 Miarfield Arc	Chesapeake VA 23321
N/A	41-22A	4525 Miarfield Arc	Stith Investment Inc.	4525 Miarfield Arc	Chesapeake, VA 23321
7327-29-3423	41-12A	9558 Brink Road	Magnolia P Allen - Life Estate - At Death Mary A Spears & Others	9558 Brink Road	Emporia VA 23847
7327-27-2407	41-12		E H Powell Estate & Others c/o Cora Powell Giles	9055 Sand Ridge Road	Hopewell VA 23860
7327-28-3792	41-12B	2750 Fish Road	Jonathan Tyrone Adams- Life Estate	4466 Bryter Drive	Douglasville GA 30135
7327-34-9474	41-13		Erie Forest Investments, LLC c/o Forest Investment Associates LP	15 Piedmont Center Ste. 1250	Atlanta GA 30305
7327-42-6514	52-2-A2	1634 Fish Road	Carol Yvonne Webb	1523 Norris Street	Camden NJ 08104
7327-53-5067	52-2-A1A		Dorothy I Ross - Life Estate - At Death - Thomas E Ross Sr	7729 Belmont Stakes Drive	Midlothian VA 23112
7327-52-6924	52-2-A1B	1558 Fish Road	Sheila Rook Hudnell or Lind D Rooks Dimps	9107 Sherwood Forest Way	Upper Marlboro MD 20772
7327-52-9933	52-2-A1C	1522 Fish Road	Deborah and Shirley Gillus	1522 Fish Road	Emporia, VA 23847
7327-62-2982	52-2-C1	1434 Fish Road	Sandra Smith	1434 Fish Road	Emporia VA 23847
7327-62-3608	52-2-C		Wandatte V Hattley or Berkley M Royster or Uzill R Weaver	1000 Brightseat Road #456	Hyattsville MD 20785
7327-51-0928	52-2-B		Wandatte V Hattley or Berkley M Royster or Uzill R Weaver	1000 Brightseat Road #456	Hyattsville MD 20785
7327-62-3024	52-1-3	1310 Fish Road	Maureen C Barnard, Leroy Gary Jr & Others c/o Maureen Barnard	1504 Rowland Street	Bronx NY 10461
7327-61-6934	52-1-4	1262 Fish Road	Leah R Ramsey c/o Marshall R Ramsey	922 Thornbriar Court	Hampton VA 23661
7327-61-7485	52-1-2B		Shirley Rawles James	7717 Orange Tree Court	Capitol Heights MD 20743
7327-61-6078	52-1-6	1092 Fish Road	Ellen Ann Rawles	1092 Fish Road	Emporia VA 23847
7327-60-9915	52-1-6E		Dessery R Green	2822 Schley Ave APT 4C	Bronx NY 10465
7327-80-6584	53-6-A		Elaxander Rook	1700 Ivey Street	Roanoke Rapids NC 27870
7336-09-8751	53-3	147 Fish Road	George B Ligon Sr & Alice R Ligon Trustees Revocable Trusts & Others c/o G B Ligon Jr	11906 Eagle Pass Drive	Chesterfield VA 23838
7337-07-5202	42-44A	1171 Fountain Creek Road	Eric N Hicks	1171 Fountain Creek Road	Emporia VA 23847
7337-07-3026	42-44B		Eric N Hicks	1171 Fountain Creek Road	Emporia VA 23847
7327-96-8756	42-45		Linda D Rook, Sheila D Rook, Angela L Rook & Sheryl D Spring c/o Cheryl Stevens	6348 Blossom View Lane	Richmond VA 23231
7327-97-9166	42-45A	1200 Fountain Creek Road	John Edward Hicks	1200 Fountain Creek Road	Emporia VA 23847
7327-97-4374	42-38B	1218 Fountain Creek Road	Jerry W Allen Sr or Lois P Allen	1218 Fountain Creek Road	Emporia VA 23847
7327-97-2771	42-38C	1330 Fountain Creek Road	Timothy Price Pearson	1412 Hamilton Street	Roanoke Rapids NC 27870
7327-98-4534	42-38	1300 Fountain Creek Road	Jerry W Allen Sr or Lois P Allen	1218 Fountain Creek Road	Emporia VA 23847
7327-89-9697	42-37E		The Lee-Hutchenson Family Limited Partnership	1075 Lynn Court	Alexandria VA 22302
7327-89-5374	42-36	442 Opal Street	Phillip L Brown	298 Opal Street	Emporia VA 23847
7327-79-7024	41-18		Phillip L Brown	298 Opal Street	Emporia VA 23847
7327-79-5325	41-21	383 Opal Street	Linwood L Brown	383 Opal Street	Emporia VA 23847
7327-79-5852	41-20	305 Opal Street	Lucinda Brown	305 Opal Street	Emporia VA 23847
7328-70-6260	41-20A		Phillip Brown	298 Opal Street	Emporia VA 23847
7328-70-7941	41-19		Timotny W Phelps c/o James R Brown	371 Opal Street	Emporia VA 23847
7328-71-3397	41-19B		Joyce D Turner	803 Peachtree Street	Emporia VA 23847
N/A	41-19A	371 Opal Street	James R. Brown Revocable Trust	371 Opal Street	Emporia, VA 23847
7328-63-6149	41-47		Lloyd E Bennett	3435 Triplet Road	Triplet VA 23868
7328-62-0975	41-48		Ben J Powell Estate c/o Joyce D Turner	803 Peachtree Street	Emporia VA 23847
7328-61-4007	41-1-2B	8740 Brink Road	Angel D Allen	8740 Brink Road	Emporia VA 23847
7328-60-1921	41-1-2A	8802 Brink Road	Penny W Powell	8802 Brink Road	Emporia VA 23847
7328-50-8875	41-1-1	8850 Brink Road	Eddie J Wright Jr & Maxine W Copeland	8850 Brink Road	Emporia VA 23847
7328-61-1372	41-49A	8747 Brink Road	Kenny W Powell	28407 Grizzard Road	Emporia VA 23847
N/A	41-49C		Kenny W Powell	28407 Grizzard Road	Emporia VA 23847
7328-52-1720	41-49	8911 Brink Road	Linda W Smith & Angel D Allen c/o Angel D Allen	8951 Brink Road	Emporia VA 23847
7328-51-2019	41-49B	8951 Brink Road	Angel D Powell or Christopher N Allen	8951 Brink Road	Emporia VA 23847
7328-33-5311	41-42	8967 Brink Road	Eddie Pair Estate c/o Bernard Pair	8967 Brink Road	Emporia VA 23847
7328-40-0803	41-43	967 Brink Road	Alvin B Pair Jr	P.O. Box 822	Emporia VA 23847
7328-30-8588	41-24A	9167 Brink Road	Dorothy A Hicks	9187 Brink Road	Emporia VA 23847

✓ 7328-30-7565	41-24B	9211 Brink Road	Myles W Bostic Jr Trustee of the Myles W Bostic Jr Living Trust	933 Poplar Avenue	Chesapeake VA 23323
✓ 7328-30-7636	41-24		Ronnie Louise Roberts or Carolene Yvette Skeeter	105-25 Farmers Boulevard	Saint Albans NY 11412
✓ 7328-23-0720	41-41	9217 Brink Road	Ronnie Louise Roberts or Carolene Yvette Skeeter	105-25 Farmers Boulevard	Saint Albans NY 11412
✓ 7328-30-3392	41-25C	9239 Brink Road	William C Bowser Sr or Barbara M Bowser	9239 Brink Road	Emporia VA 23847
7337-34-3365	42-43C	2315 Pine Log Road	Trust of Forest Hill Baptist Church	2103 Pine Log Road	Skippers VA 23879
7337-24-7053	42-48A		George L Thorpe	34666 Monroe Road	Newsoms VA 23874
7337-33-0967	42-48B		George L Thorpe	34666 Monroe Road	Newsoms VA 23874
7337-33-6901	42-49C	2342 Pine Log Road	Chester V Vaught or Diane R Vaught	2342 Pine Log Road	Skippers VA 23879
7337-33-0368	42-49A	2494 Pine Log Road	Todd B Allen or Kristie P Allen	2494 Pine Log Road	Skippers VA 23879
See EX-1 Parcel 20					
7337-40-2223	53-52		Carson E Saunders Jr Trustee of the Kathleen R Ligon Revocable Trust c/o Scott Thompson	204 South Main Street	Emporia VA 23847
7337-43-9848	42-49B		Cedric L Ferguson or Mabel B Furguson c/o Sonee Furguson Hasty	P.O. Box 457	Jackson NC 27845
7337-72-7106	53-54	358 Hilltop Lane	Massie Branch Farm, LLC	358 Hilltop Lane	Skippers VA 23879
7337-70-1904	53-53		William R Doggett or Lisa P Doggett	733 Yorktown Road	Poquoson VA 23662
7337-91-1910	53-55		Massie Branch Farm, LLC	358 Hilltop Lane	Skippers VA 23879
7337-95-2080	42-51		James S Ferguson, Sheila B Ferguson & James S Ferguson Jr	1570 Brink Road	Emporia VA 23847
7337-34-9565	42-5-11	2280 Pine Log Road	Tamara R Jackson	2280 Pine Log Road	Skippers VA 23879
7337-44-1750	42-5-10	2180 Pine Log Road	Anthony M Pernell	2180 Pine Log Road	Skippers VA 23879
7337-44-2381	42-5-9	2060 Pine Log Road	Dennis A Williams or Leslie E Williams	2060 Pine Log Road	Skippers VA 23879
7337-44-2888	42-5-8	2020 Pine Log Road	Alonza Maurice Mason	2020 Pine Log Road	Skippers VA 23879
7337-45-3093	42-5-7	2000 Pine Log Road	Charles B Nunnally or Kimberly Nunnally	P.O Box 388	Emporia VA 23847
7337-45-4184	42-5-6	1992 Pine Log Road	David L Davis	P.O. Box 562	Emporia VA 23847
7337-45-5277	42-5-5	1984 Pine Log Road	Ernest A Royal or Kimberly Kaye Royal	1984 Pine Log Road	Skippers VA 23879
7337-45-6379	42-5-4	1978 Pine Log Road	Della Palmer Goldsberry	P.O Box 842	Emporia VA 23847
7337-45-7561	42-5-3	1966 Pine Log Road	Andrea S Hines	1966 Pine Log Road	Skippers VA 23879
N/A	42-5-2	8214 Westchester	Harbour Portfolio VIII LP	8214 Westchester Suite 635	Dallas, TX 75225
7337-45-9744	42-5-1	1936 Pine Log Road	Jeffrey Bozard	1936 Pine Log Road	Skippers VA 23879
7337-55-0848	42-50C	1900 Pine Log Road	Cherfonda R Lee	1900 Pine Log Road	Skippers VA 23879
7337-56-1053	42-50B		James E Tomlinson Jr	54 Shearin Street	Emporia VA 23847
7337-56-3034	42-50D		James E Tomlinson Jr	54 Shearin Street	Emporia VA 23847
7337-56-1288	42-50A	1810 Pine Log Road	Harding A Travis Jr	1810 Pine Log Road	Skippers VA 23879
7337-34-8905	42-42A		Walter D Rook Sr & Others Trustees for Forest Hill Baptist Church	Pine Log Road	Emporia VA 23847
7337-45-0203	42-42	2103 Pine Log Road	Forest Hill Baptist Church	2103 Pine Log Road	Skippers VA 23879
7337-35-4823	42-41C		Leslie W Moseley or Debbie F Moseley	5246 Brink Road	Emporia VA 23847
N/A	42-41C1	1969 Pine Log Road	Kirk W Moseley or Erica P Moseley	1969 Pine Log Road	Skippers VA 23879
7337-36-9676	42-41B	1949 Pine Log Road	James R Gordon Jr or Kathleen H Gordon	1163 Skippers Road	Emporia VA 23847
7337-46-7176	42-43	1863 Pine Log Road	Ruby G Jones - Life Estate - At Death Rubette Lane Jones & Others	1863 Pine Log Road	Skippers VA 23879
7337-46-6336	42-41E1		Ruby G Jones - Life Estate - At Death Rubette Lane Jones & Others	1863 Pine Log Road	Skippers VA 23879
7337-47-3117	42-41E		Alamance Jones Jr or Connie T Jones	1801 Pine Log Road	Skippers VA 23879
7337-56-0556	42-41A	1801 Pine Log Road	Alamance Jones Jr	1801 Pine Log Road	Skippers VA 23879
7337-48-6589	42-41F	1453 Pine Log Road	Dane L Little or Kellie B Little	4171 Brink Road	Emporia VA 23847
N/A	42-41G	1735 Pine Log Road	Linda L Paulson	1735 Pine Log Road	Skippers VA 23879
N/A	42-41	1347 Pine Log Road	Dane L Little or Kellie B Little	4171 Brink Road	Emporia VA 23847
7337-57-6549	42-40	1491 Pine Log Rd	Alicia French	1491 Pine Log Rd	Skippers, VA 23879
7337-57-6761	42-41D	1491 Pine Log Rd	Alicia French	1491 Pine Log Rd	Skippers, VA 23879
N/A	42-53A1		A G Gordon Estate	Pine Log Road	Skippers VA 23879
7337-57-9572	42-53A	1500 Pine Log Road	F J Daughtrey Jr or Judy Arlene Wrenn	1500 Pine Log Road	Skippers VA 23879
7337-97-7286	42-52		Charles Randolph Garris	711 Diamond Grove Road	Skippers VA 23879
7337-98-9455	43-42		Donald Mitchell Driver & James Rodney Driver c/o James Rodney Driver	750 Pine Log Road	Skippers VA 23879
7348-00-0021	43-3C		Jimmie L Currin Jr	4840 Thornwood Avenue	Portsmouth VA 23703
7338-80-6220	42-54C		Smithfield-Carroll's Farms Murphy-Brown, LLC	P.O. Box 856	Warsaw NC 28398

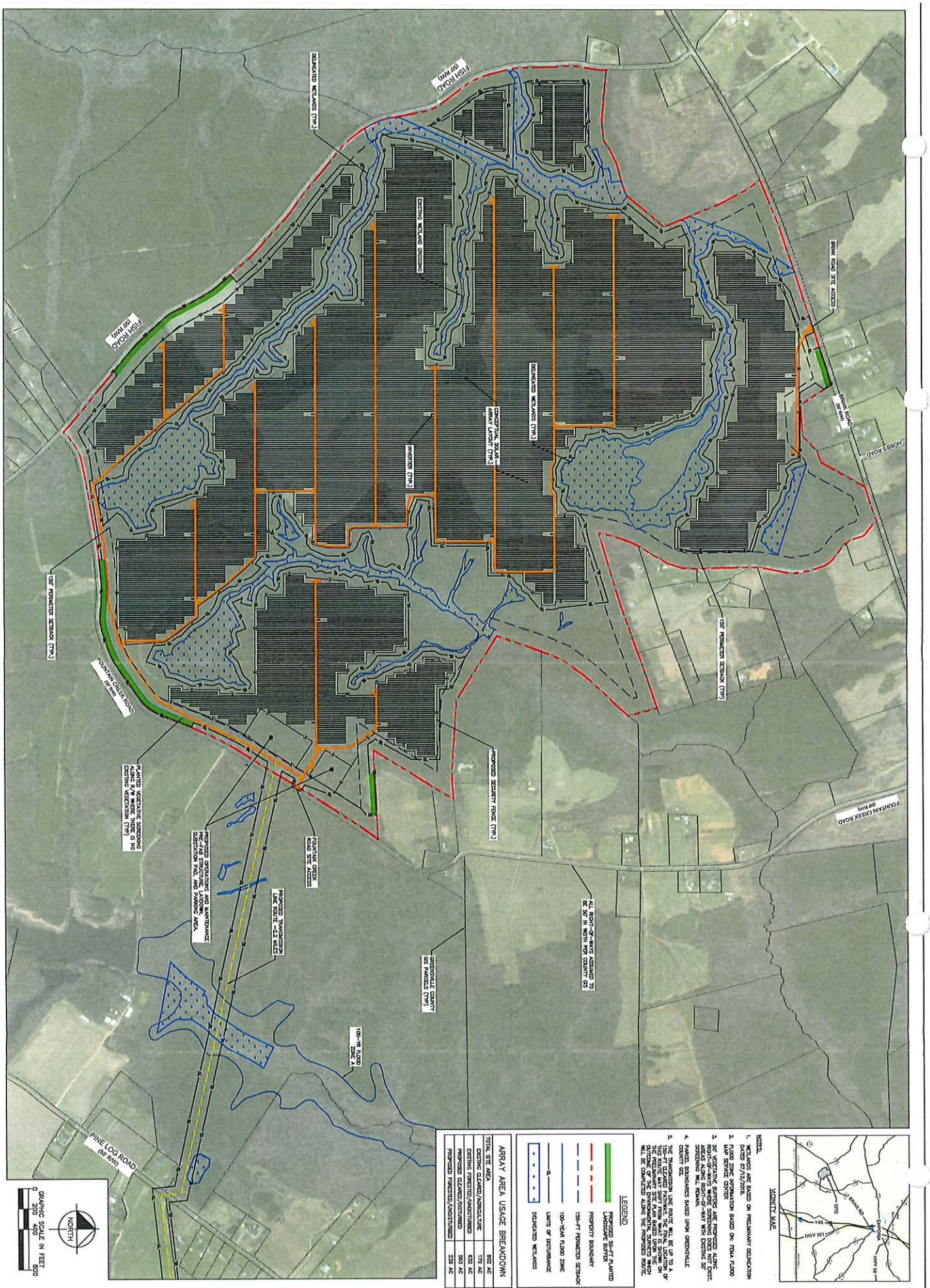
7337-69-9697	42-54I		David J Creath or Glenda D Creath	914 Pine Log Road	Skippers VA 23879
7338-70-1527	42-54I		David J Creath or Glenda D Creath	914 Pine Log Road	Skippers VA 23879
7338-71-1018	42-54D	3002 Diamond Grove Road	Betty Louise Bradley Gordon - Life Estate at Death - Remainder to Her Children	3002 Diamond Grove Road	Skippers VA 23879
7338-60-6465	42B-3-8	998 Pine Log Road	Lyman Allen Little or Kathie Whitehead Little	998 Pine Log Road	Skippers VA 23879
7338-60-5234	42B-3-9	998 Pine Log Road	Lyman Allen Little or Kathie W Little	998 Pine Log Road	Skippers VA 23879
7337-69-5966	42B-3-10	1058 Pine Log Road	Haywood D Jones or Martha E Jones	1058 Pine Log Road	Skippers VA 23879
7337-69-4508	42B-4-12		Haywood D Jones or Martha E Jones	1058 Pine Log Road	Skippers VA 23879
7337-69-2408	42-54B	11633 Highway 92 West	Mecklenburg Electric Cooperative David Lipscomb	11633 Highway 92 West	Chase City, VA 23924
7338-50-7623	42-55	5351 Broad Street Rd	Willis Michael Driver	5351 Broad Street Rd	Louisa, VA 23093
7338-71-8733	42-54A	750 Pine Log Rd	James Rodney Driver	750 Pine Log Rd	Skippers, VA 23879
N/A	42-54A2	18 Dalton Ct	Donald Mitchell Driver	18 Dalton Ct	Roanoke Rapids, NC 27870

ATTACHMENT B - SITE AND TRANSMISSION LINE PARCELS

	GPIN	MAP#	ADDRESS	NAME	MAILING ADDRESS	CITY, STATE, ZIP
✓	7327-67-2217	41-17		Pender L Smith Jr, Alfred Smith & Alice S Bivens Life Estates - c/o Patricia Clary	405 Laurel Street	Emporia VA 23847
✓	7327-55-1154	41-16		Tredway and Blake LLC c/o Elizabeth B Ferguson	3903 Rock Bridge Road	Skippers VA 23879
✓	7337-04-9551	42-48	2499 Pine Long Road	Pender L Smith Jr, Alfred Smith & Alice S Bivens Life Estates - c/o Patricia Clary	405 Laurel Street	Emporia VA 23847
	7337-53-9419	42-49		James S Ferguson Jr	1091 Brink Road	Emporia VA 23847
	7337-65-7683	42-50		James S Ferguson Jr & Sheila B Ferguson	1570 Brink Road	Emporia VA 23847
	7337-77-4654	42-53		Linda W Smith & Sandy M Webb c/o Linda W Smith	409 Pinecrest Avenue	Roanoke Rapids NC 27870
✓	7337-78-5999	42-3-A	1290 Pine Log Road	Charles Roberts Jr or Susie S Roberts	1290 Pine Log Road	Skippers VA 23879
	7338-70-7127	42-54		Smithfield-Carroll's Farms Murphy-Brown, LLC	P.O. Box 856	Warsaw NC 28398

ATTACHMENT C

PRELIMINARY SITE PLAN AND VISUAL SIMULATIONS



ARRAY AREA USAGE BREAKDOWN	
TOTAL SITE AREA	892 AC
EXISTING CLEARED/AGRICULTURE	176 AC
EXISTING FORESTED/UNDISTURBED	626 AC
PROPOSED CLEARED/DISTURBED	340 AC
PROPOSED FORESTED/UNDISTURBED	239 AC

LEGEND
- PROPOSED SOLAR ARRAY
- PROPOSED PLANTED VEGETATIVE BUFFER
- PROPERTY BOUNDARY
- 150-FT PERIMETER SETBACK
- 100-YEAR FLOOD ZONE
- LIMITS OF DISTURBANCE
- DELINEATED WETLANDS

NOTES:
1. WETLANDS ARE BASED ON PRELIMINARY DELINEATION BY KHA.
2. FLOOD INFORMATION BASED ON FEMA FLOOD MAP SERVICE CENTER
3. 50' VEGETATIVE BUFFERS ARE PROPOSED ALONG RIGHT-OF-WAYS WHERE SCREENING DOES NOT EXIST. ADDITIONAL SCREENING MAY BE REQUIRED ALONG NEIGHBORING PROPERTIES WITH EXISTING RESIDENCES.
4. PARCEL BOUNDARIES BASED UPON GREENSVILLE COUNTY GIS.
5. THE TRANSMISSION LINE ROUTE WILL BE UP TO A 150-FT CLEARED PATHWAY. THE FINAL LOCATION OF THE TRANSMISSION LINE WILL BE DETERMINED DURING THE PRELIMINARY SITE PLAN BASED UPON THE FINAL SUBSTATION LOCATION. SURVEYS WILL BE COMPLETED ALONG THE PROPOSED ROUTE.

VICINITY MAP

SHEET NUMBER EX1.0	FOUNTAIN CREEK SOLAR GREENSVILLE COUNTY VIRGINIA	PRELIMINARY SITE PLAN	KHA PROJECT 013239000 DATE 10/08/2018 SCALE AS SHOWN DESIGNED BY JSL DRAWN BY JSL CHECKED BY CJH

Kimley»Horn

421 FAYETTEVILLE STREET, SUITE 600, RALEIGH, NC 27601
PHONE: 919-835-1460
WWW.KIMLEY-HORN.COM

No.	REVISIONS	DATE	BY

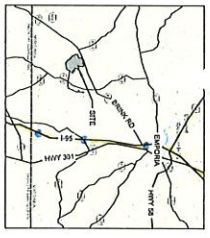
LEGEND

- PROPOSED 50-FT PLANTED LANDSCAPE BUFFER
- PROPERTY BOUNDARY
- 150-FT PERIMETER SETBACK
- 100-YEAR FLOOD ZONE
- LIMITS OF DISTURBANCE
- DELINEATED WETLANDS

NOTES:

1. WETLANDS ARE BASED ON PRELIMINARY DELINEATION DATED 07/13/2018.
2. FLOOD ZONE INFORMATION BASED ON FEMA FLOOD MAP SERVICE CENTER.
3. 50' VEGETATIVE BUFFERS ARE PROPOSED ALONG RIGHT-OF-WAYS WHERE SCREENING DOES NOT EXIST. SCREENING WILL REMAIN.
4. PARCEL BOUNDARIES BASED UPON GREENSVILLE COUNTY GIS.
5. THE TRANSMISSION LINE ROUTE WILL BE UP TO A 150' WIDE CORRIDOR. THE FINAL LOCATION OF THE TRANSMISSION LINE ROUTE MAY SHIFT FROM WHAT IS SHOWN ON THIS PRELIMINARY SITE PLAN BASED UPON THE OUTCOME OF FIELD SURVEYS. SURVEYS WILL BE COMPLETED ALONG THE PROPOSED ROUTE.

VICINITY MAP



GRAPHIC SCALE IN FEET
0 250 500 1000

NORTH

SHEET NUMBER	FOUNTAIN CREEK SOLAR	PRELIMINARY SITE PLAN	KHA PROJECT 013239000
EX2.0	GREENSVILLE COUNTY VIRGINIA		DATE 10/08/2018
			SCALE AS SHOWN
			DESIGNED BY JSL
			DRAWN BY JSL
			CHECKED BY CJH

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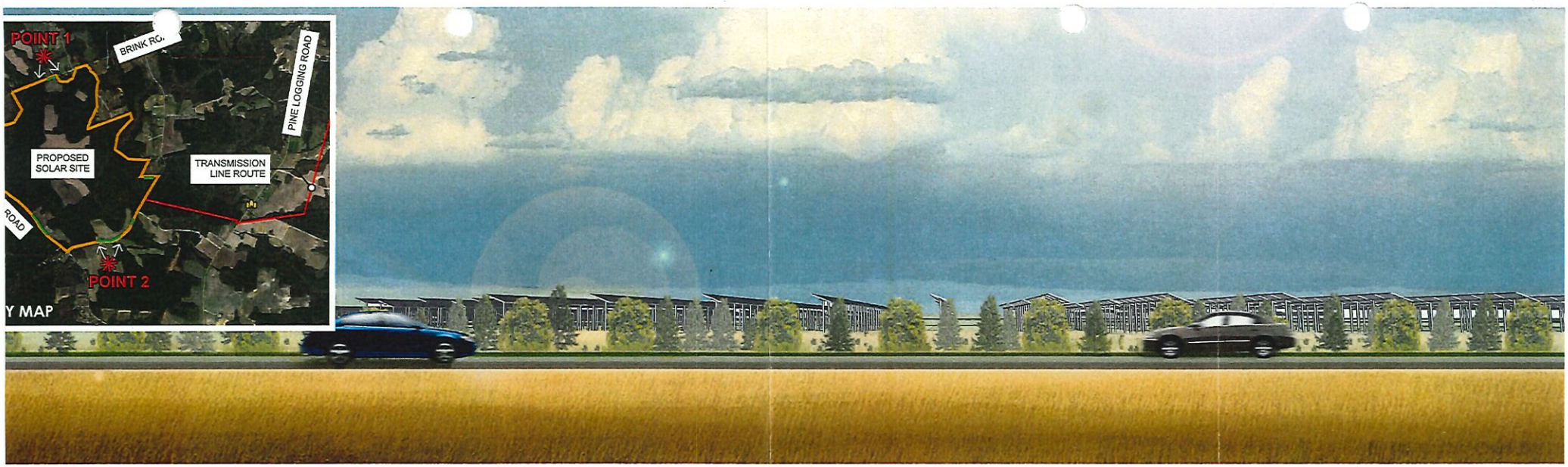
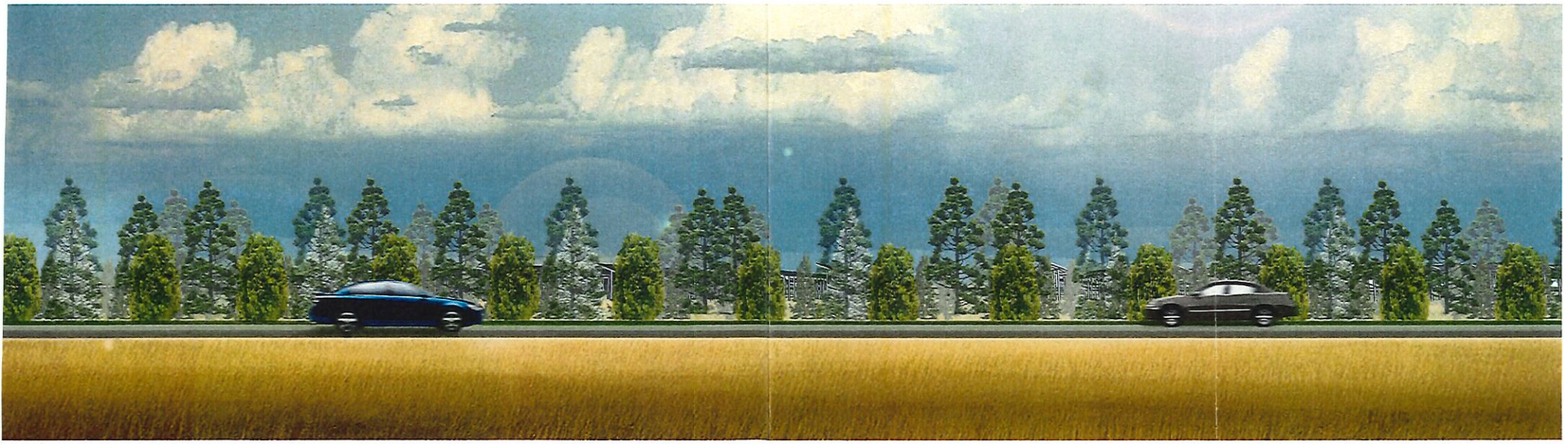
No.	REVISIONS	DATE	BY



)UNTAIN CREEK - Point 1 & 2 (Landscape at Planting)

ensville County, VA

October 3, 2018 Kimley»Horn



)UNTAIN CREEK - Point 1 & 2 (Landscape at 6 Years)

ensville County, VA

October 3, 2018 Kimley»Horn

OUNTAIN CREEK - Point 3 (Existing Landscape)

eensville County, VA

October 3, 2018 Kimley»Horn

ATTACHMENT D

BALANCING AGRICULTURAL PRODUCTIVITY WITH GROUND-BASED SOLAR PHOTOVOLTAIC (PV) DEVELOPMENT

NC CLEAN ENERGY TECHNOLOGY CENTER

Balancing Agricultural Productivity with Ground-Based Solar Photovoltaic (PV) Development

AUGUST 2017

NC STATE UNIVERSITY

NC CLEAN ENERGY TECHNOLOGY CENTER

NC STATE UNIVERSITY

Balancing Agricultural Productivity with Ground-Based Solar Photovoltaic (PV) Development

Introduction

For centuries North Carolina farmers have made a major contribution to the state's economy by working the land and providing billions of pounds of agricultural and forestry products to meet demands for food and fiber. This resource serves as a foundational economic building block for the state. North Carolina's farming and forestry community provides North Carolinians and people across the world with food and fiber. That said, the demands of our growing, modern society require renewable forms of energy to begin to replace finite non-renewable energy resources that have traditionally provided the means for transportation, electricity, and much more.

Given that land and climatic conditions suitable for agriculture are finite, solar development may compete with agricultural land use. One use converts sunlight and fertilizer into food and fiber, while the other converts sunlight into electricity. The purpose of this paper is to explore the extent to which solar photovoltaic facilities and agricultural production compete for land use, as well as the extent to which agricultural production is affected by solar development. The paper is divided into two sections:

(1) Understanding the Context of Solar Development and Agriculture in North Carolina.
- (1.1) Developing Renewable Energy,
- (1.2) Landowner Land Use Choice,
- (1.3) Solar Facility Construction,
- (1.4) Duration of Solar Use,

(2) Weighing the Impact of PV Development on Agriculture
- (2.1) Solar PV Land Use
- (2.2) Impact on Agricultural Productivity

1. Understanding the Context of Solar Development and Agriculture in North Carolina

This section provides some background on solar development in North Carolina. By illustrating the existing demand for renewable energy (1.1), touching on the state's political climate towards private land use (1.2), and highlighting two important considerations of PV development (1.3 and 1.4), the context surrounding the two competing land uses of solar development and agriculture can be better understood. As agriculture is and has been a dominant, established land

Version 1, 08/10/17

use in this state for generations, discussion in this section will primarily focus on the increasing demands of land to be used for solar development.

1.1 Developing Renewable Energy

Currently, almost all of North Carolina's electricity is generated from fuels, such as coal, natural gas, and uranium, which are produced outside the state. Some coal plants in North Carolina are reaching the end of their useful lives and being retired.[1,2] Alternative sources of energy, such as solar and wind, have become much more economically attractive in the last several years, making it possible to economically replace some nuclear, coal, and gas electricity generation with these sources.[3]

More than three hundred privately financed utility-scale solar facilities operate in North Carolina under current electricity prices, regulations, and policies, with more planned for the future. As with any new technology, price drops and performance improvements may be expected over time as production volumes increase and experience is gained. Since 2009, the total cost to develop and build a utility-scale solar facility in North Carolina has dropped from over $5 per watt to about $1 per watt. This rapid cost reduction in utility-scale solar facilities has greatly improved the financial viability of solar projects; many solar projects are now being planned even without the North Carolina renewable energy tax credit that expired at the end of 2015.[4,5]

In addition to the increasingly attractive economics, some of the shift towards solar energy has been driven by policy choices. Solar and other types of renewable energy have many benefits that have motivated support from policymakers. For instance, they do not use imported fuel, reducing our exposure to fuel price volatility. Solar energy also does not produce the air pollution and greenhouse gases emitted by fossil fuel-powered electricity generation, and it avoids some other environmental risks associated with fossil and nuclear fuels such as coal ash and radioactive waste disposal. Reduction of air pollution has been part of state and national policy for decades, and the U.S. has seen steadily improving air quality as a result[6] Solar and other clean energy sources assist in this ongoing reduction in air pollution.

Solar energy offers many benefits to North Carolina. However, while solar development provides a source of clean in-state energy, it requires land to do so. This means that solar energy projects will sometimes compete with other potential land uses.

1.2 Landowner Land Use Choice

North Carolina policy generally leaves land use decisions in the hands of landowners. That said, the state, local, and federal governments can encourage or discourage specific landowner choices through the incentives or disincentives that they provide for particular uses, as well as through various forms of regulation, such as zoning rules and environmental restrictions. The balance of state-provided incentives for agricultural or solar energy production can, in some cases, be the determining factor in the decision to invest in solar or agriculture development. Also, the current grid infrastructure limits the sites feasible for solar development; it is only feasible to connect solar to certain locations in the grid and only to a limited density.

North Carolina has granted local governments the power to regulate land use in their jurisdictions, although state and federal rules apply in many circumstances. This means that local governments can manage land development with the needs of the community in mind, while also safeguarding natural resources. These land-use regulations can put limits on the allowed uses for some land and thus limit landowners' options, in some cases affecting the viability of solar development. Some agricultural land has been exempted from certain regulations due to "grandfathering," and changing the land use to solar may remove these exemptions, which can affect the ability to return the land to agricultural use in the future.[7]

Land use regulations that may be relevant to solar development, depending on the location, can include (but are not limited to):[8]

- Local zoning and land use rules (fencing, buffer zones between buildings and roads, border shrubs/trees, etc.)
- Floodplain development rules
- Erosion and sedimentation rules
- Permitting regarding military and air traffic impact
- Water quality rules (i.e. Neuse nutrient strategy rules, Coastal Area Management Act rules)
- USDA wetlands impact rules

To determine whether these and other rules are relevant for a potential solar development, landowners and solar developers should consult their local government planning departments, the Soil and Water Conservation Division of the N.C. Department of Agriculture and Consumer Services, the USDA Natural Resources Conservation Service office, and the USDA Farm Services Agency.

1.3 Solar Facility Construction

Solar panels are supported by steel or aluminum racks. The racks are attached to galvanized steel posts driven 6-8 feet into the ground without concrete, although very occasionally, site conditions require the use of cement grout in the pile hole. The only concrete is generally at the inverter/transformer pads which are typically about 10' by 20' each. There is usually no more than one such pad per MW of AC capacity. At some sites these pads are precast concrete or steel skids that sit above grade on helical steel piers. Much of the wiring at the site is above-ground attached to the racking under the rows of panels. The rest of the wiring is 2 to 3 feet underground either as direct-bury cables or in 2"-6" PVC conduit. Most sites involve minimal grading of the land.

Every site provides access for vehicles, which requires roads, or "access aisles," to be constructed. These roads are sometimes improved with gravel, but they do not require application of concrete or asphalt. Many sites only use gravel close to the entry to the public Right of Way, as required by NCDOT regulation, with the rest of the access aisles as simply compacted native soil. Some developers use reusable wooden logging mats to provide temporary stabilization during construction to avoid the need for the addition of gravel. A best practice when building a gravel access aisle is to strip the organic topsoil, place a geotextile fabric under the aggregate and redistribute the topsoil on site to assist in soil stabilization. This will provide stability for the aggregate, allow for more efficient removal of the gravel at the end of the project's life cycle by

providing separation between aggregate and subgrade, while preserving the valuable topsoil on site for future agricultural use.[9] Well-drafted leases will specify allowable construction techniques and locations of roads and other infrastructure. The NC Department of Environmental Quality (DEQ) requires soil erosion and sedimentation control plans and permits and inspects implemented measures on the site until vegetative groundcover is established.

1.4 Duration of Solar Use

Currently in North Carolina most utility-scale solar projects have a 15-year Power Purchase Agreement (PPA) with the local electric utility. Some developers prefer to purchase the land, while others prefer to lease, depending on the project's business model and financing arrangements. Typical land leases have a term of 15 to 30 years, often with several optional 5-year extensions.[10] While specific lease rates are generally undisclosed, in our understanding lease rates often range between $500 and $1,000 per acre per year. Most solar PV panel manufacturers include a 25-year power warranty on their panels, which cover the panels to produce at least 80% of their original power output at the expiration of the warranty period.

Modern solar facilities may be considered a temporary, albeit long-term, use of the land, in the sense that the systems can be readily removed from the site at the end of their productive life. At this point, the site can be returned to agricultural use, albeit with a potential for some short-term reduction in productivity due to loss of topsoil, compaction, change in pH, and change in available nutrients. Leasing farmland for solar PV use, particularly land that is not actively being farmed today, is a viable way to preserve land for potential future agricultural use. PV use is particularly valuable in this regard when compared to commercial or residential development, which require changes to the land that are very difficult to reverse. For landowners struggling to retain ownership of their land due to financial strains, solar leasing may provide a vital, stable income solution. It may also serve as a more appealing alternative to selling their land to buyers intending to use the land for other, more permanent non-agricultural uses.

While it is very difficult to predict the state of electricity, agriculture, and real estate markets 25 or more years into the future, existing circumstances can provide some insight into the likelihood of today's solar facilities continuing as solar facilities at the end of the initial PV modules' useful lifetime. The he economics of existing solar facilities are such that many of the projects built today are likely to update some of their equipment after 20 or more years and continue to operate as a solar electricity facility for many more years. The ability to facilitate interconnection to the electric grid provides great value to a landowner. A parcel of land featuring this capability in today's market will likely also appeal to solar developers in the future due to the infrastructure cost savings.

2. Weighing the Impact of PV Development on Agriculture

The purpose of this section is to explore how the competing land uses of solar development and agriculture interact and can coexist with each other. Subsection 2.1 provides analysis of data and metrics that quantify the current and potential amount of solar development on agricultural land in North Carolina. Subsection 2.2 explores the impacts that solar development could have on future agricultural production on the developed site and neighboring properties. Taken together,

Section 2 of this factsheet provides several factors to consider when weighing the impact of PV development on agriculture.

2.1 Solar PV Land-Use

The NC Sustainable Energy Association (NCSEA) with the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) used GIS software to quantify the amount of solar land use. As of December 2016, solar installations occupied 0.2 percent (9,074 acres) of North Carolina's 4.75 million acres of cropland.[11] NCDA&CS has provided an updated estimate; they estimate that 14,864 acres of cropland, or 0.31 percent of the total, were occupied by solar development at the end of the first quarter of 2017.[12] NCSEA and NCDA&CS were able to locate and quantify solar use for 318 of 341 currently-installed utility-scale facilities in North Carolina. A map of the solar installations in the state prepared by NCSEA is available at: http://energyncmaps.org/gis/solar/index.html. [13] The researchers extrapolated the per-MW findings of the 318 sites found in aerial photos to generate an estimate for the remaining 23 projects not yet visible in the latest aerial photography. Across all projects, 79% of solar project area was formerly farmland, defined as land identified from aerial photography to have been used for crops, hay, or pasture before solar development. On average, the solar projects occupied 5.78 acres per MW_{AC}.

N.C. has been losing farmland to various forms of development for many years. Over the last decade, North Carolina has lost about one million acres of cropland to development and housing. Since 1940, total cropland in N.C. has fallen from 8.42 million acres to 4.75 million acres (as of 2012). The North Carolina Department of Agriculture has identified farmland preservation as one of its top priorities since 2005.

As of the end of 2016, solar PV installations added 2,300 MW_{AC} of solar generating capacity to North Carolina's electricity grid, making NC second in the nation for installed solar PV capacity. These installations generate enough electricity to power approximately 256,000 average N.C. homes, equaling 6.2% of all households in the state.[14] NCSEA and NCDA&CS published the summary of their land-use analysis in February of 2017 and NCSEA released a report on this research in April of this year.[15]

If the current siting and production trends were to continue until ground-mounted solar produced, on average, an amount of electricity equal to *100%* of N.C.'s current electricity use, solar facilities would cover about 8% of current N.C. cropland.[16] This is an unrealistic extreme to illustrate the limited possible magnitude of land usage for solar even at very high solar generation levels, yet even this scenario would occupy only about half of the N.C. cropland acreage lost to development in the last 10 years. Even if solar were to provide all of our electricity, ground-mounted utility-scale solar will almost certainly not be the only source of electricity. As PV prices continue to decline it is likely that North Carolina will see more and more rooftop and parking lot canopies, reducing the need for green field development. A recent Department of Energy study found that rooftop systems have the technical capability to meet 23.5% of North Carolina's electricity demand.[17]

A more likely scenario, even assuming that fossil fuel and nuclear based electricity is entirely phased out, is that other sources of renewable electricity and technologies will meet a large portion of our electricity needs. A Stanford University study of the optimal mix of renewable energy sources for each state to achieve 100% renewable energy found that North Carolina would get only 26.5% of its electricity from utility-scale solar plants.[18] At this still highly expanded level of solar development, based off of the 8.3% land use for 100% solar figure calculated earlier, the amount of NC cropland used for solar would be around 2.2%.

More realistically, in the next decade or two, solar electricity may grow to provide around 5 – 20% of North Carolina's electricity, which would allow solar to meet, or nearly meet, the full requirements of the North Carolina Renewable Energy and Energy Efficiency Portfolio Standard. At the 12.5% REPS requirement, this is about 13 GW_{AC} of PV, which will require about 75,000 acres of land at the average historic density found in the NCCETC/NCDA study. This is not an insignificant amount of land, but if split between agricultural and non-agricultural land at the same ratio as the first 2.3 GW installed in NC this represents about 1.1% of cropland in the state. NCSEA projects that by 2030, utility-scale solar will provide 5.03% of North Carolina's electricity and use 0.57% of available cropland.[19]

Solar energy's land use requirements are comparable to those of existing energy sources. According to an MIT study, supplying 100% of U.S. electricity demand in 2050 with solar would require us of about 0.4% of the country's land area; this is only half the amount of land currently used to grow corn for ethanol fuel production, and about the same amount of land as has been disturbed by surface coal mining.[20]

For landowners interested in solar development, it is important to understand the agricultural value of the land before entering into a solar lease agreement. Careful due diligence in the siting phase can help mitigate the use of the most valuable farmland. Landowners can contact their county tax office for property value information. The following online resources can assist landowners and developers in assessing the agricultural value of land before selecting the final footprint for solar development:

- www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/nra/dma/
  The USDA Natural Resources Conservation Service provides several tools in this link to identify soil types on property.
- www.ncmhtd.com/rye/ The North Carolina Realistic Yields Database provides landowners with a useful mapping and soil analysis tool that produces realistic productivity yields for expected crops given the landowner's property location and soil type.

2.2 Impact on Agricultural Productivity

This subsection provides an overview of impacts that solar development may have on agricultural land. The discussion of these impacts is divided into the following subtopics: construction grading and soil preservation, compaction, erosion, weed control, toxicity, and pollinators, followed by a brief discussion of decommissioning. The subtopic discussions illustrate that solar development, with proper planning and implementation, results in a small but manageable impact on the future agricultural productivity of the land on which it is sited. Further, these discussions also illustrate that solar development is unlikely to significantly affect the agricultural productivity of neighboring properties now or in the future.

Construction Grading and Soil Preservation

The amount of grading necessary to prepare a parcel for a utility-scale solar facility is dependent on the slope of land and the type of solar mounting used. In much of N.C., fixed-tilt mounting of PV requires little to no grading for installation of the PV system. Single-axis tracking systems that slowly rotate each row of panels to track the sun's path across the sky generally require flatter land (typically less than 8% grading) and thus more often require grading of the site, particularly for projects in the Piedmont region or farther west.[21] Typical construction practices require that topsoil be stripped and stockpiled prior to cut/fill operations. The stockpiled topsoil will be redistributed across graded areas, to assist in growing adequate ground cover as quickly as possible to provide ground stabilization. The stripping, stockpiling and redistribution of topsoil in this manner will have some impact on the amount of organics and nutrients that remain in the soil immediately after placement. However, proper ground stabilization practices include soil testing to determine the appropriate levels of lime, fertilizer and seed to be applied to establish ground cover. Proper installation practices require these additives to be tilled into the soil, which effectively reduces the compaction of the upper soil stratum, typically to a depth of 8"-12". Typical solar projects will not remove any topsoil from the project site, partly due to financial implications, but more importantly due to its value in establishing ground cover as quickly as possible[22] (removing soil also requires a mining permit).[23] Most landowners steer solar projects to their least productive soils on a given piece of property to the extent practical.[24]

Soil Quality

Modern agriculture relies on regular additions of lime and fertilizer to maintain soil pH and fertility. Solar facilities maintain vegetative ground covers that can help build soil quality over time, which may require lime and fertilizer to be applied. When the vegetation is cut, the organic matter is left in place to decompose which adds valuable organic matter to the soil. A facility operation and maintenance schedule should include a plan for maintenance of sufficient plant groundcover to protect soil from erosion. Maintaining healthy plant cover will require monitoring of soil fertility and may call for the addition of fertilizer or lime to ensure sufficient nutrients are available for plant growth and that soil pH is adequate. Vegetation mixes may help balance soil nutrient needs, but will need to be managed. Species composition will change over time.[25] NREL and others are researching and using vegetation mixes that include many native grasses with deep root systems; many include some nitrogen fixing plants as well. According to a study published in July 2016 that measured soil and air microclimate, vegetation and greenhouse gas emissions for twelve months under photovoltaic (PV) arrays, in gaps between PV arrays and in control areas at a UK solar sited on species-rich grassland, UK scientists found no change in soil properties among the three locations.[26]After a solar project is removed, a routine soil test (available from the North Carolina Department of Agriculture) should be obtained to determine fertility requirements, including lime, for optimum crop production.

Compaction

Soil compaction can negatively impact soil productivity and will occur to some degree on every solar site. Soil compaction can also limit water infiltration into the soil environment, and

lead to greater surface water runoff during rain events.[27] In addition to the roads built in and around solar project sites, the construction of the facility itself as well as regular use of lawn mowers compacts the soil, decreasing the ability of plant roots to grow. However, use of land as a solar site will avoid agriculture-related activities that can induce compaction, such as tillage. There are no data available on the degree of compaction common at solar facilities, but it is possible that some sites could experience heavy compaction in frequently used areas. In cases of heavy compaction, hard pans in the soil will form that can take decades to naturally free up; however, tractor implements such as chisels and vibrators designed to break up hard pan can often remove enough compaction to restore productivity. To prevent damage to soil due to compaction, landowners can negotiate for practices that will result in the least amount of compaction and for roads to be constructed on less productive land. Additionally, maintaining healthy groundcover, especially varieties with deep root systems, can serve to keep the soil arable for potential future agricultural use. The appropriate use of alternative vegetative maintenance strategies, such as grazing with sheep, can reduce the use of mowing equipment onsite and therefore the compaction that may result from using this equipment.[28] Furthermore, livestock grazing works to cycle nutrients in the pasture ecosystem onsite and improve the soil.

Erosion

According to its current Stormwater Design Manual, the N.C. Department of Environmental Quality allows solar panels associated with ground-mounted solar farms to be considered *pervious* if configured such that they promote sheet flow of stormwater from the panels and allow natural infiltration of stormwater into the ground beneath the panels.[29] For solar development, an erosion control and sedimentation permit is required, which involves on-site inspections and approval by the North Carolina Department of Environmental Quality. The permit requires establishment of permanent vegetative ground cover sufficient to restrain erosion; according to DEQ staff, the site must be "completely stabilized," although this does not require a specific percentage of ground cover.[30] In-depth information on erosion control and sedimentation laws, rules, principles, and practices is available at the NC DEQ's website, at http://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/erosion-sediment-control-planning-design-manual. Once permanent vegetation is established it will be necessary to maintain soil pH and fertility as mentioned above in order to ensure sufficient, healthy, and continuous ground cover for erosion control.

Weed and Vegetation Control

Maintenance of vegetation on site can be accomplished using several options, including but not limited to the following: mowing, weed eaters, herbicides, and sheep. Reductions in fertilizer use on the site will slow growth of vegetation and weeds. Mowing allows the landowner to have the option of laying cut grass or vegetation on grounds of site to decompose and improve long-term soil fertility. In some cases, landowners have used grazing animals, normally sheep, to frequent the solar site grounds and control the vegetation and weeds, which also returns organic matter to the soil on site

Like most lawns and parks, many utility-scale solar facilities in N.C. use a combination of mowing and herbicides to maintain the vegetation. When using herbicides, applicators are advised

to be mindful of label instructions and local conditions. Herbicide persistence is affected by the organic matter content and moisture level of the soil. The importance of complying with legal responsibilities in using the treatments cannot be stressed enough, especially for land located near surface water, land where the surface is near the water table, or where application might carry over to other neighboring lands.

Herbicide use at solar facilities is typically similar to that in agriculture, and the types of herbicides used are similar between the two uses. As such, the impact of herbicides used at solar facilities on neighboring land and the environment is likely to be no more than that of conventional agriculture. Herbicide use differs widely among different crops and farming techniques, so the change in herbicide appliance between agricultural and solar use will vary in individual cases, but in the aggregate, there is no reason to believe that solar facilities will result in more herbicide impacts on neighboring lands than do current agricultural uses. [31] Herbicide use can be discontinued 1-2 years before decommissioning of a site, minimizing any residual impact on crop production at former solar sites.[32]

A number of sites use sheep at low densities to maintain vegetation during the growing season, although the sheep do not fully replace the need for mowing and/or herbicide use. The sheep are leased from sheep farmers, and the demand for sheep at solar facilities has been beneficial for North Carolina's sheep industry.[33] The grazing of sheep at solar facilities incorporates local farmers into the management of the sites, engaging the local community with solar development. The growth of solar farms represents a huge opportunity for the North Carolina sheep industry, with thousands of acres that are fenced well for sheep, and allow North Carolina farmers to diversify into new agricultural products for which there is increasing demand.[34]

Toxicity

There is no significant cause for concern about leaking and leaching of toxic materials from solar site infrastructure.[35] Naturally occurring rain is adequate to generally keep the panels clean enough for good electricity production. If panels do need to be washed, the washing process requires nothing more than soap and water. Additionally, the materials used to build each panel provide negligible risk of toxic exposure to the soil, environment, or people in the community. Details about toxicity for aluminum and zinc are described below, and more information on the potential for human toxicity can be found in the NCSU Health and Safety Impacts of Solar Photovoltaics white paper.

Aluminum

Aluminum is very common in soils around the world, including those common in North Carolina. In fact, the earth's crust is about 7% aluminum, and most soils are over 1% aluminum![36] The aluminum is generally unavailable to plants as long as the soil pH is above about 5.5. In acidic soils many forms of aluminum become more bio-available to plants; this can be toxic to many plant species.[37] This effect is one of the major reason many plants do not tolerate very acidic soils. The use of aluminum building materials releases negligible amounts of aluminum during their useful life because the material is

so corrosion resistant. [38] The aluminum frames of PV modules are anodized which adds a very thin hard coating of aluminum oxide to the exterior of the aluminum that greatly improves aluminum's already-high resistance to corrosion. Therefore, any minute amount of aluminum that could be released by corrosion from aluminum construction materials during the life of a solar project will not materially add to the thousands or millions of pounds of aluminum naturally present in the soil of a typical N.C. solar facility. The common practice of liming soils to maintain appropriate soil pH for crop systems alleviates most, if not all, concerns about aluminum impacting crop growth in the future.

Zinc

Zinc from galvanized components, including support posts for solar panels, can move into the soil.[39] Zinc from building material stockpiles has been previously noted as a localized problem for peanut production in some North Carolina fields.[40] While it is difficult to predict in advance the degree to which this will occur, it is relatively simple to collect soil samples and monitor this situation in existing installations. Analysis of zinc is included in routine soil testing procedures used by the NC Department of Agriculture & Consumer Services Agronomic Services Division Laboratory. Awareness of zinc concentrations in the soil, and any spatial patterns noted with depth and distance from structures, should allow producers to determine if the field is adequate for desired crops as is. If zinc limitations exist, awareness of concentrations and spatial distribution patterns may indicate the potential for deep tillage, liming, or crop selection alternatives required for successful agricultural use. Of the agronomic crops grown in NC, peanuts are the most sensitive crop to zinc toxicity. Based on information from the N.C. Department of Agriculture and Consumer Services, there is risk of toxicity to peanuts when the zinc availability index (Zn-AI) is 250 or higher, particularly in low-pH situations. Risk increases with increasing soil test levels, especially if pH management through a liming program is not followed. For most other crops, zinc toxicity does not become problematic until the Zn-AI index reaches 2,000-3,000.[41]

Pollinators

Solar projects with appropriate vegetation can provide habitat for pollinators, as well as other wildlife.[42] Rather than planting common turf grasses, some solar facilities are starting to use seed mixes of native grasses and pollinator-friendly flowering plants as ground cover in solar facilities.[43,44] This provides habitat for pollinators, which can be beneficial to neighboring farms. Minnesota passed the country's first statewide standards for "pollinator friendly solar" in 2016. According to Fresh Energy, a clean energy nonprofit in St. Paul, more than 2,300 acres of these plants took root near solar panels last year, according to Fresh Energy.[45] Solar facilities can also cooperate with commercial beekeepers to facilitate honey production, although this may conflict with providing habitat for wild pollinators.[46,47] Pollinators provide benefits for agricultural production at nearby farms where insect-pollinated crops are grown[48]

Decommissioning

If land used for a solar facility is to be returned to agricultural use in the future, it will be necessary to remove the solar equipment from the land. This process is known as decommissioning. Decommissioning is basically the construction process in reverse; it involves removal of the solar panels, breakup of support pads, removal of access roads, replacement of any displaced soil, and revegetation.

Solar development often takes place on leased land, although it also occurs on land owned by solar companies. When leased land is involved, it must be determined whether the landowner or the solar developer bears responsibility for decommissioning. Responsibilities for decommissioning are lease-specific in North Carolina. It is important for landowners to consider decommissioning when setting lease terms, although landowners may choose in some cases to accept decommissioning responsibility themselves. Although state rules on solar decommissioning do not currently exist in North Carolina, local jurisdictions can choose to adopt regulations pertaining to decommissioning.

The materials recovered in the decommissioning process have significant economic value, which can help pay for the costs of decommissioning. Some engineering analyses have indicated that the salvage value of recovered materials is more than enough to pay for the removal of all the materials and to return the site to its pre-construction state.[49,50,51,52]

NCSU has produced several resources that provide more information on decommissioning. They include:

- Health and Safety Impacts of Solar Photovoltaics[53]
- Template Ordinance for Solar Energy Development in North Carolina[54]
- Working Paper: State Regulation of Solar Decommissioning[55]
- Landowner Solar Leasing: Contract Terms Explained[56]

Summary

The purpose of this paper is to explore the extent to which competition exists between solar development and agriculture and the extent to which the agricultural productivity of land is affected by solar development. Discussion on this topic was divided into two sections: (1) Understanding the Context of Solar Development and Agriculture in North Carolina and (2) Weighing the Impact of PV Development on Agriculture. In these sections, information and tools were provided to aid in understanding the impact of solar development on agricultural land. Equipped with the information and tools provided by this paper, landowners may be able to better evaluate the viability of solar development on their land.

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ATTACHMENT E

HEALTH AND SAFETY IMPACTS OF PHOTOVOLTAICS

NC CLEAN ENERGY TECHNOLOGY CENTER

NC STATE UNIVERSITY

Health and Safety Impacts of Solar Photovoltaics

The increasing presence of utility-scale solar photovoltaic (PV) systems (sometimes referred to as solar farms) is a rather new development in North Carolina's landscape. Due to the new and unknown nature of this technology, it is natural for communities near such developments to be concerned about health and safety impacts. Unfortunately, the quick emergence of utility-scale solar has cultivated fertile grounds for myths and half-truths about the health impacts of this technology, which can lead to unnecessary fear and conflict.

Photovoltaic (PV) technologies and solar inverters are not known to pose any significant health dangers to their neighbors. The most important dangers posed are increased highway traffic during the relative short construction period and dangers posed to trespassers of contact with high voltage equipment. This latter risk is mitigated by signage and the security measures that industry uses to deter trespassing. As will be discussed in more detail below, risks of site contamination are much less than for most other industrial uses because PV technologies employ few toxic chemicals and those used are used in very small quantities. Due to the reduction in the pollution from fossil-fuel-fired electric generators, the overall impact of solar development on human health is overwhelmingly positive. This pollution reduction results from a partial replacement of fossil-fuel fired generation by emission-free PV-generated electricity, which reduces harmful sulfur dioxide (SO_2), nitrogen oxides (NO_x), and fine particulate matter ($PM_{2.5}$). Analysis from the National Renewable Energy Laboratory and the Lawrence Berkeley National Laboratory, both affiliates of the U.S. Department of Energy, estimates the health-related air quality benefits to the southeast region from solar PV generators to be worth 8.0 ¢ per kilowatt-hour of solar generation..[1] This is in addition to the value of the electricity and suggests that the air quality benefits of solar are worth more than the electricity itself.

Even though we have only recently seen large-scale installation of PV technologies, the technology and its potential impacts have been studied since the 1950s. A combination of this solar-specific research and general scientific research has led to the scientific community having a good understanding of the science behind potential health and safety impacts of solar energy. This paper utilizes the latest scientific literature and knowledge of solar practices in N.C. to address the health and safety risks associated with solar PV technology. These risks are extremely small, far less than those associated with common activities such as driving a car, and vastly outweighed by health benefits of the generation of clean electricity.

This paper addresses the potential health and safety impacts of solar PV development in North Carolina, organized into the following four categories:

(1) Hazardous Materials
(2) Electromagnetic Fields (EMF)
(3) Electric Shock and Arc Flash
(4) Fire Safety

1. Hazardous Materials

One of the more common concerns towards solar is that the panels (referred to as "modules" in the solar industry) consist of toxic materials that endanger public health. However, as shown in this section, solar energy systems may contain small amounts of toxic materials, but these materials do not endanger public health. To understand potential toxic hazards coming from a solar project, one must understand system installation, materials used, the panel end-of-life protocols, and system operation. This section will examine these aspects of a solar farm and the potential for toxicity impacts in the following subsections:

(1.2) Project Installation/Construction
(1.2) System Components
    1.2.1 Solar Panels: Construction and Durability
    1.2.2 Photovoltaic technologies
        (a) Crystalline Silicon
        (b) Cadmium Telluride (CdTe)
        (c) CIS/CIGS
    1.2.3 Panel End of Life Management
    1.2.4 Non-panel System Components
(1.3) Operations and Maintenance

1.1 Project Installation/Construction

The system installation, or construction, process does not require toxic chemicals or processes. The site is mechanically cleared of large vegetation, fences are constructed, and the land is surveyed to layout exact installation locations. Trenches for underground wiring are dug and support posts are driven into the ground. The solar panels are bolted to steel and aluminum support structures and wired together. Inverter pads are installed, and an inverter and transformer are installed on each pad. Once everything is connected, the system is tested, and only then turned on.

Figure 1: Utility-scale solar facility (5 MW_{AC}) located in Catawba County. Source: Strata Solar

1.2 System Components

1.2.1 Solar Panels: Construction and Durability

Solar PV panels typically consist of glass, polymer, aluminum, copper, and semiconductor materials that can be recovered and recycled at the end of their useful life.[2] Today there are two PV technologies used in PV panels at utility-scale solar facilities, silicon, and thin film. As of 2016, all thin film used in North Carolina solar facilities are cadmium telluride (CdTe) panels from the US manufacturer First Solar, but there are other thin film PV panels available on the market, such as Solar Frontier's CIGS panels. Crystalline silicon technology consists of silicon wafers which are made into cells and assembled into panels, thin film technologies consist of thin layers of semiconductor material deposited onto glass, polymer or metal substrates. While there are differences in the components and manufacturing processes of these two types of solar technologies, many aspects of their PV panel construction are very similar. Specifics about each type of PV chemistry as it relates to toxicity are covered in subsections a, b, and c in section 1.2.2; on crystalline silicon, cadmium telluride, and CIS/CIGS respectively. The rest of this section applies equally to both silicon and thin film panels.

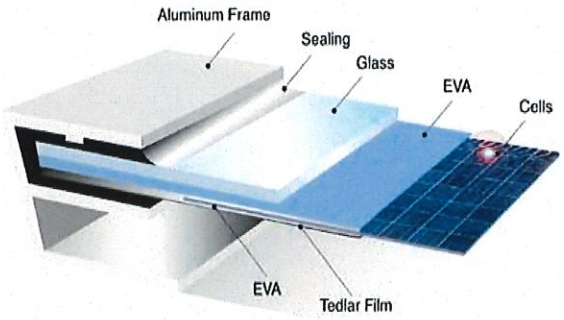

Figure 2: Components of crystalline silicon panels. The vast majority of silicon panels consist of a glass sheet on the topside with an aluminum frame providing structural support. Image Source: www.riteksolar.com.tw

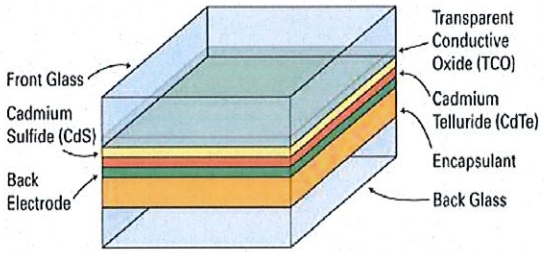

Figure 3: Layers of a common frameless thin-film panel (CdTe). Many thin film panels are frameless, including the most common thin-film panels, First Solar's CdTe. Frameless panels have protective glass on both the front and back of the panel. Layer thicknesses not to scale. Image Source: www.homepower.com

To provide decades of corrosion-free operation, PV cells in PV panels are encapsulated from air and moisture between two layers of plastic. The encapsulation layers are protected on the top with a layer of tempered glass and on the backside with a polymer sheet. Frameless modules include a protective layer of glass on the rear of the panel, which may also be tempered. The plastic ethylene-vinyl acetate (EVA) commonly provides the cell encapsulation. For decades, this same material has been used between layers of tempered glass to give car windshields and hurricane windows their great strength. In the same way that a car windshield cracks but stays intact, the EVA layers in PV panels keep broken panels intact (see Figure 4). Thus, a damaged module does not generally create small pieces of debris; instead, it largely remains together as one piece.

Figure 4: The mangled PV panels in this picture illustrate the nature of broken solar panels; the glass cracks but the panel is still in one piece. Image Source: http://img.alibaba.com/photo/115259576/broken_solar_panel.jpg

PV panels constructed with the same basic components as modern panels have been installed across the globe for well over thirty years..[3] The long-term durability and performance demonstrated over these decades, as well as the results of accelerated lifetime testing, helped lead to an industry-standard 25-year power production warranty for PV panels. These power warranties warrant a PV panel to produce at least 80% of their original nameplate production after 25 years of use. A recent SolarCity and DNV GL study reported that today's quality PV panels should be expected to reliably and efficiently produce power for thirty-five years..[4]

Local building codes require all structures, including ground mounted solar arrays, to be engineered to withstand anticipated wind speeds, as defined by the local wind speed requirements. Many racking products are available in versions engineered for wind speeds of up to 150 miles per hour, which is significantly higher than the wind speed requirement anywhere in North Carolina. The strength of PV mounting structures were demonstrated during Hurricane Sandy in 2012 and again during Hurricane Matthew in 2016. During Hurricane Sandy, the many large-scale solar facilities in New Jersey and New York at that time suffered only minor damage..[5] In the fall of 2016, the US and Caribbean experienced destructive winds and torrential rains from Hurricane Matthew, yet one leading solar tracker manufacturer reported that their numerous systems in the impacted area received zero damage from wind or flooding..[6]

In the event of a catastrophic event capable of damaging solar equipment, such as a tornado, the system will almost certainly have property insurance that will cover the cost to cleanup and repair the project. It is in the best interest of the system owner to protect their investment against such risks. It is also in their interest to get the project repaired and producing full power as soon as possible. Therefore, the investment in adequate insurance is a wise business practice for the system owner. For the same

reasons, adequate insurance coverage is also generally a requirement of the bank or firm providing financing for the project.

1.2.2 Photovoltaic (PV) Technologies

a. Crystalline Silicon

This subsection explores the toxicity of silicon-based PV panels and concludes that they do not pose a material risk of toxicity to public health and safety. Modern crystalline silicon PV panels, which account for over 90% of solar PV panels installed today, are, more or less, a commodity product. The overwhelming majority of panels installed in North Carolina are crystalline silicon panels that are informally classified as Tier I panels. Tier I panels are from well-respected manufacturers that have a good chance of being able to honor warranty claims. Tier I panels are understood to be of high quality, with predictable performance, durability, and content. Well over 80% (by weight) of the content of a PV panel is the tempered glass front and the aluminum frame, both of which are common building materials. Most of the remaining portion are common plastics, including polyethylene terephthalate in the backsheet, EVA encapsulation of the PV cells, polyphenyl ether in the junction box, and polyethylene insulation on the wire leads. The active, working components of the system are the silicon photovoltaic cells, the small electrical leads connecting them together, and to the wires coming out of the back of the panel. The electricity generating and conducting components makeup less than 5% of the weight of most panels. The PV cell itself is nearly 100% silicon, and silicon is the second most common element in the Earth's crust. The silicon for PV cells is obtained by high-temperature processing of quartz sand (SiO_2) that removes its oxygen molecules. The refined silicon is converted to a PV cell by adding extremely small amounts of boron and phosphorus, both of which are common and of very low toxicity.

The other minor components of the PV cell are also generally benign; however, some contain lead, which is a human toxicant that is particularly harmful to young children. The minor components include an extremely thin antireflective coating (silicon nitride or titanium dioxide), a thin layer of aluminum on the rear, and thin strips of silver alloy that are screen-printed on the front and rear of cell..[7] In order for the front and rear electrodes to make effective electrical contact with the proper layer of the PV cell, other materials (called glass frit) are mixed with the silver alloy and then heated to etch the metals into the cell. This glass frit historically contains a small amount of lead (Pb) in the form of lead oxide. The 60 or 72 PV cells in a PV panel are connected by soldering thin solder-covered copper tabs from the back of one cell to the front of the next cell. Traditionally a tin-based solder containing some lead (Pb) is used, but some manufacturers have switched to lead-free solder. The glass frit and/or the solder may contain trace amounts of other metals, potentially including some with human toxicity such as cadmium. However, testing to simulate the potential for leaching from broken panels, which is discussed in more detail below, did not find a potential toxicity threat from these trace elements. Therefore, the tiny amount of lead in the grass frit and the solder is the only part of silicon PV panels with a potential to create a negative health impact. However, as described below, the very limited amount of lead involved and its strong physical and chemical attachment to other components of the PV panel means that even in worst-case scenarios the health hazard it poses is insignificant.

As with many electronic industries, the solder in silicon PV panels has historically been a lead-based solder, often 36% lead, due to the superior properties of such solder. However, recent advances in lead-free solders have spurred a trend among PV panel manufacturers to reduce or remove the lead in their panels. According to the 2015 Solar Scorecard from the Silicon Valley Toxics Coalition, a group that tracks environmental responsibility of photovoltaic panel manufacturers, fourteen companies (increased from twelve companies in 2014) manufacture PV panels certified to meet the European Restriction of

Hazardous Substances (RoHS) standard. This means that the amount of cadmium and lead in the panels they manufacture fall below the RoHS thresholds, which are set by the European Union and serve as the world's de facto standard for hazardous substances in manufactured goods..[8] The Restriction of Hazardous Substances (RoHS) standard requires that the maximum concentration found in any homogenous material in a produce is less than 0.01% cadmium and less than 0.10% lead, therefore, any solder can be no more than 0.10% lead..[9]

While some manufacturers are producing PV panels that meet the RoHS standard, there is no requirement that they do so because the RoHS Directive explicitly states that the directive does not apply to photovoltaic panels..[10] The justification for this is provided in item 17 of the current RoHS Directive: "The development of renewable forms of energy is one of the Union's key objectives, and the contribution made by renewable energy sources to environmental and climate objectives is crucial. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources (4) recalls that there should be coherence between those objectives and other Union environmental legislation. Consequently, this Directive should not prevent the development of renewable energy technologies that have no negative impact on health and the environment and that are sustainable and economically viable."

The use of lead is common in our modern economy. However, only about 0.5% of the annual lead consumption in the U.S. is for electronic solder for all uses; PV solder makes up only a tiny portion of this 0.5%. Close to 90% of lead consumption in the US is in batteries, which do not encapsulate the pounds of lead contained in each typical automotive battery. This puts the lead in batteries at great risk of leaching into the environment. Estimates for the lead in a single PV panel with lead-based solder range from 1.6 to 24 grams of lead, with 13g (less than half of an ounce) per panel seen most often in the literature..[11] At 13 g/panel.[12], each panel contains one-half of the lead in a typical 12-gauge shotgun shell.. This amount equates to roughly 1/750th of the lead in a single car battery. In a panel, it is all durably encapsulated from air or water for the full life of the panel..[14]

As indicated by their 20 to 30-year power warranty, PV modules are designed for a long service life, generally over 25 years. For a panel to comply with its 25-year power warranty, its internal components, including lead, must be sealed from any moisture. Otherwise, they would corrode and the panel's output would fall below power warranty levels. Thus, the lead in operating PV modules is not at risk of release to the environment during their service lifetime. In extreme experiments, researchers have shown that lead can leach from crushed or pulverized panels..[15, .16] However, more real-world tests designed to represent typical trash compaction that are used to classify waste as hazardous or non-hazardous show no danger from leaching..[17, .18] For more information about PV panel end-of-life, see the Panel Disposal section.

As illustrated throughout this section, silicon-based PV panels do not pose a material threat to public health and safety. The only aspect of the panels with potential toxicity concerns is the very small amount of lead in some panels. However, any lead in a panel is well sealed from environmental exposure for the operating lifetime of the solar panel and thus not at risk of release into the environment.

b. Cadmium Telluride (CdTe) PV Panels

This subsection examines the components of a cadmium telluride (CdTe) PV panel. Research demonstrates that they pose negligible toxicity risk to public health and safety while significantly reducing the public's exposure to cadmium by reducing coal emissions. As of mid-2016, a few hundred MWs of

cadmium telluride (CdTe) panels, all manufactured by the U.S. company First Solar, have been installed in North Carolina.

Questions about the potential health and environmental impacts from the use of this PV technology are related to the concern that these panels contain cadmium, a toxic heavy metal. However, scientific studies have shown that cadmium telluride differs from cadmium due to its high chemical and thermal stability..[19] Research has shown that the tiny amount of cadmium in these panels does not pose a health or safety risk..[20] Further, there are very compelling reasons to welcome its adoption due to reductions in unhealthy pollution associated with burning coal. Every GWh of electricity generated by burning coal produces about 4 grams of cadmium air emissions..[21] Even though North Carolina produces a significant fraction of our electricity from coal, electricity from solar offsets much more natural gas than coal due to natural gas plants being able to adjust their rate of production more easily and quickly. If solar electricity offsets 90% natural gas and 10% coal, each 5-megawatt (5 MW_{AC}, which is generally 7 MW_{DC}) CdTe solar facility in North Carolina keeps about 157 grams, or about a third of a pound, of cadmium *out of* our environment..[22, 23]

Cadmium is toxic, but all the approximately 7 grams of cadmium in one CdTe panel is in the form of a chemical compound cadmium telluride, .[24] which has 1/100th the toxicity of free cadmium..[25]. Cadmium telluride is a very stable compound that is non-volatile and non-soluble in water. Even in the case of a fire, research shows that less than 0.1% of the cadmium is released when a CdTe panel is exposed to fire. The fire melts the glass and encapsulates over 99.9% of the cadmium in the molten glass..[27]

It is important to understand the source of the cadmium used to manufacture CdTe PV panels. The cadmium is a byproduct of zinc and lead refining. The element is collected from emissions and waste streams during the production of these metals and combined with tellurium to create the CdTe used in PV panels. If the cadmium were not collected for use in the PV panels or other products, it would otherwise either be stockpiled for future use, cemented and buried, or disposed of..[28] Nearly all the cadmium in old or broken panels can be recycled which can eventually serve as the primary source of cadmium for new PV panels..[29]

Similar to silicon-based PV panels, CdTe panels are constructed of a tempered glass front, one instead of two clear plastic encapsulation layers, and a rear heat strengthened glass backing (together >98% by weight). The final product is built to withstand exposure to the elements without significant damage for over 25 years. While not representative of damage that may occur in the field or even at a landfill, laboratory evidence has illustrated that when panels are ground into a fine powder, very acidic water is able to leach portions of the cadmium and tellurium,.[30] similar to the process used to recycle CdTe panels. Like many silicon-based panels, CdTe panels are reported (as far back ask 1998.[31]) to pass the EPA's Toxic Characteristic Leaching Procedure (TCLP) test, which tests the potential for crushed panels in a landfill to leach hazardous substances into groundwater..[32] Passing this test means that they are classified as non-hazardous waste and can be deposited in landfills..[33, 34] For more information about PV panel end-of-life, see the Panel Disposal section.

There is also concern of environmental impact resulting from potential catastrophic events involving CdTe PV panels. An analysis of worst-case scenarios for environmental impact from CdTe PV panels, including earthquakes, fires, and floods, was conducted by the University of Tokyo in 2013. After reviewing the extensive international body of research on CdTe PV technology, their report concluded, "Even in the worst-case scenarios, it is unlikely that the Cd concentrations in air and sea water will exceed the environmental regulation values."[35] In a worst-case scenario of damaged panels abandoned on the ground, insignificant amounts of cadmium will leach from the panels. This is because this scenario is

much less conducive (larger module pieces, less acidity) to leaching than the conditions of the EPA's TCLP test used to simulate landfill conditions, which CdTe panels pass..[36]

First Solar, a U.S. company, and the only significant supplier of CdTe panels, has a robust panel take-back and recycling program that has been operating commercially since 2005..[37] The company states that it is "committed to providing a commercially attractive recycling solution for photovoltaic (PV) power plant and module owners to help them meet their module (end of life) EOL obligation simply, cost-effectively and responsibly." First Solar global recycling services to their customers to collect and recycle panels once they reach the end of productive life whether due to age or damage. These recycling service agreements are structured to be financially attractive to both First Solar and the solar panel owner. For First Solar, the contract provides the company with an affordable source of raw materials needed for new panels and presumably a diminished risk of undesired release of Cd. The contract also benefits the solar panel owner by allowing them to avoid tipping fees at a waste disposal site. The legal contract helps provide peace of mind by ensuring compliance by both parties when considering the continuing trend of rising disposal costs and increasing regulatory requirements.

c. CIS/CIGS and other PV technologies

Copper indium gallium selenide PV technology, often referred to as CIGS, is the second most common type of thin-film PV panel but a distant second behind CdTe. CIGS cells are composed of a thin layer of copper, indium, gallium, and selenium on a glass or plastic backing. None of these elements are very toxic, although selenium is a regulated metal under the Federal Resource Conservation and Recovery Act (RCRA)..[38] The cells often also have an extremely thin layer of cadmium sulfide that contains a tiny amount of cadmium, which is toxic. The promise of high efficiency CIGS panels drove heavy investment in this technology in the past. However, researchers have struggled to transfer high efficiency success in the lab to low-cost full-scale panels in the field..[39] Recently, a CIGS manufacturer based in Japan, Solar Frontier, has achieved some market success with a rigid, glass-faced CIGS module that competes with silicon panels. Solar Frontier produces the majority of CIS panels on the market today..[40] Notably, these panels are RoHS compliant,.[41] thus meeting the rigorous toxicity standard adopted by the European Union even thought this directive exempts PV panels. The authors are unaware of any completed or proposed utility-scale system in North Carolina using CIS/CIGS panels.

1.2.3 Panel End-of-Life Management

Concerns about the volume, disposal, toxicity, and recycling of PV panels are addressed in this subsection. To put the volume of PV waste into perspective, consider that by 2050, when PV systems installed in 2020 will reach the end of their lives, it is estimated that the global annual PV panel waste tonnage will be 10% of the 2014 global e-waste tonnage..[42] In the U.S., end-of-life disposal of solar products is governed by the Federal Resource Conservation and Recovery Act (RCRA), as well as state policies in some situations. RCRA separates waste into hazardous (not accepted at ordinary landfill) and solid waste (generally accepted at ordinary landfill) based on a series of rules. According to RCRA, the way to determine if a PV panel is classified as hazardous waste is the Toxic Characteristic Leaching Procedure (TCLP) test. This EPA test is designed to simulate landfill disposal and determine the risk of hazardous substances leaching out of the landfill..[43,44,45] Multiple sources report that most modern PV panels (both crystalline silicon and cadmium telluride) pass the TCLP test..[46,47] Some studies found that some older (1990s) crystalline silicon panels, and perhaps some newer crystalline silicon panels (specifics are not given about vintage of panels tested), do not pass the lead (Pb) leachate limits in the TCLP test..[48,49]

The test begins with the crushing of a panel into centimeter-sized pieces. The pieces are then mixed in an acid bath. After tumbling for eighteen hours, the fluid is tested for forty hazardous substances that all must be below specific threshold levels to pass the test. Research comparing TCLP conditions to conditions of damaged panels in the field found that simulated landfill conditions provide overly conservative estimates of leaching for field-damaged panels..[50] Additionally, research in Japan has found no detectable Cd leaching from cracked CdTe panels when exposed to simulated acid rain..[51]

Although modern panels can generally be landfilled, they can also be recycled. Even though recent waste volume has not been adequate to support significant PV-specific recycling infrastructure, the existing recycling industry in North Carolina reports that it recycles much of the current small volume of broken PV panels. In an informal survey conducted by the NC Clean Energy Technology Center survey in early 2016, seven of the eight large active North Carolina utility-scale solar developers surveyed reported that they send damaged panels back to the manufacturer and/or to a local recycler. Only one developer reported sending damaged panels to the landfill.

The developers reported at that time that they are usually paid a small amount per panel by local recycling firms. In early 2017, a PV developer reported that a local recycler was charging a small fee per panel to recycle damaged PV panels. The local recycling firm known to authors to accept PV panels described their current PV panel recycling practice as of early 2016 as removing the aluminum frame for local recycling and removing the wire leads for local copper recycling. The remainder of the panel is sent to a facility for processing the non-metallic portions of crushed vehicles, referred to as "fluff" in the recycling industry..[52] This processing within existing general recycling plants allows for significant material recovery of major components, including glass which is 80% of the module weight, but at lower yields than PV-specific recycling plants. Notably almost half of the material value in a PV panel is in the few grams of silver contained in almost every PV panel produced today. In the long-term, dedicated PV panel recycling plants can increase treatment capacities and maximize revenues resulting in better output quality and the ability to recover a greater fraction of the useful materials..[53] PV-specific panel recycling technologies have been researched and implemented to some extent for the past decade, and have been shown to be able to recover over 95% of PV material (semiconductor) and over 90% of the glass in a PV panel..[54]

A look at global PV recycling trends hints at the future possibilities of the practice in our country. Europe installed MW-scale volumes of PV years before the U.S. In 2007, a public-private partnership between the European Union and the solar industry set up a voluntary collection and recycling system called PV CYCLE. This arrangement was later made mandatory under the EU's WEEE directive, a program for waste electrical and electronic equipment..[55] Its member companies (PV panel producers) fully finance the association. This makes it possible for end-users to return the member companies' defective panels for recycling at any of the over 300 collection points around Europe without added costs. Additionally, PV CYCLE will pick up batches of 40 or more used panels at no cost to the user. This arrangement has been very successful, collecting and recycling over 13,000 tons by the end of 2015..[56]

In 2012, the WEEE Directive added the end-of-life collection and recycling of PV panels to its scope..[57] This directive is based on the principle of extended-producer-responsibility. It has a global impact because producers that want to sell into the EU market are legally responsible for end-of-life management. Starting in 2018, this directive targets that 85% of PV products "put in the market" in Europe are recovered and 80% is prepared for reuse and recycling.

The success of the PV panel collection and recycling practices in Europe provides promise for the future of recycling in the U.S. In mid-2016, the US Solar Energy Industry Association (SEIA) announced that they are starting a national solar panel recycling program with the guidance and support of many

leading PV panel producers..[58] The program will aggregate the services offered by recycling vendors and PV manufacturers, which will make it easier for consumers to select a cost-effective and environmentally responsible end-of-life management solution for their PV products. According to SEIA, they are planning the program in an effort to make the entire industry landfill-free. In addition to the national recycling network program, the program will provide a portal for system owners and consumers with information on how to responsibly recycle their PV systems.

While a cautious approach toward the potential for negative environmental and/or health impacts from retired PV panels is fully warranted, this section has shown that the positive health impacts of reduced emissions from fossil fuel combustion from PV systems more than outweighs any potential risk. Testing shows that silicon and CdTe panels are both safe to dispose of in landfills, and are also safe in worst case conditions of abandonment or damage in a disaster. Additionally, analysis by local engineers has found that the current salvage value of the equipment in a utility scale PV facility generally exceeds general contractor estimates for the cost to remove the entire PV system..[59, 60, 61]

1.2.4 Non-Panel System Components (racking, wiring, inverter, transformer)

While previous toxicity subsections discussed PV panels, this subsection describes the non-panel components of utility-scale PV systems and investigates any potential public health and safety concerns. The most significant non-panel component of a ground-mounted PV system is the mounting structure of the rows of panels, commonly referred to as "racking". The vertical post portion of the racking is galvanized steel and the remaining above-ground racking components are either galvanized steel or aluminum, which are both extremely common and benign building materials. The inverters that make the solar generated electricity ready to send to the grid have weather-proof steel enclosures that protect the working components from the elements. The only fluids that they might contain are associated with their cooling systems, which are not unlike the cooling system in a computer. Many inverters today are RoHS compliant.

The electrical transformers (to boost the inverter output voltage to the voltage of the utility connection point) do contain a liquid cooling oil. However, the fluid used for that function is either a non-toxic mineral oil or a biodegradable non-toxic vegetable oil, such as BIOTEMP from ABB. These vegetable transformer oils have the additional advantage of being much less flammable than traditional mineral oils. Significant health hazards are associated with old transformers containing cooling oil with toxic PCBs. Transfers with PCB-containing oil were common before PCBs were outlawed in the U.S. in 1979. PCBs still exist in older transformers in the field across the country.

Other than a few utility research sites, there are no batteries on- or off-site associated with utility-scale solar energy facilities in North Carolina, avoiding any potential health or safety concerns related to battery technologies. However, as battery technologies continue to improve and prices continue to decline we are likely to start seeing some batteries at solar facilities. Lithium ion batteries currently dominate the world utility-scale battery market, which are not very toxic. No non-panel system components were found to pose any health or environmental dangers.

1.4 Operations and Maintenance – Panel Washing and Vegetation Control

Throughout the eastern U.S., the climate provides frequent and heavy enough rain to keep panels adequately clean. This dependable weather pattern eliminates the need to wash the panels on a regular basis. Some system owners may choose to wash panels as often as once a year to increase production, but most in N.C. do not regularly wash any PV panels. Dirt build up over time may justify panel washing a few times over the panels' lifetime; however, nothing more than soap and water are required for this activity.

The maintenance of ground-mounted PV facilities requires that vegetation be kept low, both for aesthetics and to avoid shading of the PV panels. Several approaches are used to maintain vegetation at NC solar facilities, including planting of limited-height species, mowing, weed-eating, herbicides, and grazing livestock (sheep). The following descriptions of vegetation maintenance practices are based on interviews with several solar developers as well as with three maintenance firms that together are contracted to maintain well over 100 of the solar facilities in N.C. The majority of solar facilities in North Carolina maintain vegetation primarily by mowing. Each row of panels has a single row of supports, allowing sickle mowers to mow under the panels. The sites usually require mowing about once a month during the growing season. Some sites employ sheep to graze the site, which greatly reduces the human effort required to maintain the vegetation and produces high quality lamb meat..[62]

In addition to mowing and weed eating, solar facilities often use some herbicides. Solar facilities generally do not spray herbicides over the entire acreage; rather they apply them only in strategic locations such as at the base of the perimeter fence, around exterior vegetative buffer, on interior dirt roads, and near the panel support posts. Also unlike many row crop operations, solar facilities generally use only general use herbicides, which are available over the counter, as opposed to restricted use herbicides commonly used in commercial agriculture that require a special restricted use license. The herbicides used at solar facilities are primarily 2-4-D and glyphosate (Round-up®), which are two of the most common herbicides used in lawns, parks, and agriculture across the country. One maintenance firm that was interviewed sprays the grass with a class of herbicide known as a growth regulator in order to slow the growth of grass so that mowing is only required twice a year. Growth regulators are commonly used on highway roadsides and golf courses for the same purpose. A commercial pesticide applicator license is required for anyone other than the landowner to apply herbicides, which helps ensure that all applicators are adequately educated about proper herbicide use and application. The license must be renewed annually and requires passing of a certification exam appropriate to the area in which the applicator wishes to work. Based on the limited data available, it appears that solar facilities in N.C. generally use significantly less herbicides per acre than most commercial agriculture or lawn maintenance services.

2. Electromagnetic Fields (EMF)

PV systems do not emit any material during their operation; however, they do generate electromagnetic fields (EMF), sometimes referred to as radiation. EMF produced by electricity is non-ionizing radiation, meaning the radiation has enough energy to move atoms in a molecule around (experienced as heat), but not enough energy to remove electrons from an atom or molecule (ionize) or to damage DNA. As shown below, modern humans are all exposed to EMF throughout our daily lives without negative health impact. Someone outside of the fenced perimeter of a solar facility is not exposed to significant EMF from the solar facility. Therefore, there is no negative health impact from the EMF

produced in a solar farm. The following paragraphs provide some additional background and detail to support this conclusion.

Since the 1970s, some have expressed concern over potential health consequences of EMF from electricity, but no studies have ever shown this EMF to cause health problems..[63] These concerns are based on some epidemiological studies that found a slight increase in childhood leukemia associated with average exposure to residential power-frequency magnetic fields above 0.3 to 0.4 μT (microteslas) (equal to 3.0 to 4.0 mG (milligauss)). μT and mG are both units used to measure magnetic field strength. For comparison, the average exposure for people in the U.S. is one mG or 0.1 μT, with about 1% of the population with an average exposure in excess of 0.4 μT (or 4 mG)..[64] These epidemiological studies, which found an association but not a causal relationship, led the World Health Organization's International Agency for Research on Cancer (IARC) to classify ELF magnetic fields as "possibly carcinogenic to humans". Coffee also has this classification. This classification means there is limited evidence but not enough evidence to designate as either a "probable carcinogen" or "human carcinogen". Overall, there is very little concern that ELF EMF damages public health. The only concern that does exist is for long-term exposure above 0.4 μT (4 mG) that may have some connection to increased cases of childhood leukemia. In 1997, the National Academies of Science were directed by Congress to examine this concern and concluded:

> "Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive and developmental effects.".[65]

There are two aspects to electromagnetic fields, an electric field and a magnetic field. The electric field is generated by voltage and the magnetic field is generated by electric current, i.e., moving electrons. A task group of scientific experts convened by the World Health Organization (WHO) in 2005 concluded that there were no substantive health issues related to *electric* fields (0 to 100,000 Hz) at levels generally encountered by members of the public..[66] The relatively low voltages in a solar facility and the fact that electric fields are easily shielded (i.e., blocked) by common materials, such as plastic, metal, or soil means that there is no concern of negative health impacts from the electric fields generated by a solar facility. Thus, the remainder of this section addresses magnetic fields. Magnetic fields are not shielded by most common materials and thus can easily pass through them. Both types of fields are strongest close to the source of electric generation and weaken quickly with distance from the source.

The direct current (DC) electricity produced by PV panels produce stationary (0 Hz) electric and magnetic fields. Because of minimal concern about potential risks of stationary fields, little scientific research has examined stationary fields' impact on human health..[67] In even the largest PV facilities, the DC voltages and currents are not very high. One can illustrate the weakness of the EMF generated by a PV panel by placing a compass on an operating solar panel and observing that the needle still points north.

While the electricity throughout the majority of a solar site is DC electricity, the inverters convert this DC electricity to alternating current (AC) electricity matching the 60 Hz frequency of the grid. Therefore, the inverters and the wires delivering this power to the grid are producing non-stationary EMF, known as extremely low frequency (ELF) EMF, normally oscillating with a frequency of 60 Hz. This frequency is at the low-energy end of the electromagnetic spectrum. Therefore, it has less energy than

other commonly encountered types of non-ionizing radiation like radio waves, infrared radiation, and visible light.

The wide use of electricity results in background levels of ELF EMFs in nearly all locations where people spend time – homes, workplaces, schools, cars, the supermarket, etc. A person's average exposure depends upon the sources they encounter, how close they are to them, and the amount of time they spend there..[68] As stated above, the average exposure to magnetic fields in the U.S. is estimated to be around one mG or 0.1 μT, but can vary considerably depending on a person's exposure to EMF from electrical devices and wiring..[69] At times we are often exposed to much higher ELF magnetic fields, for example when standing three feet from a refrigerator the ELF magnetic field is 6 mG and when standing three feet from a microwave oven the field is about 50 mG..[70] The strength of these fields diminish quickly with distance from the source, but when surrounded by electricity in our homes and other buildings moving away from one source moves you closer to another. However, unless you are inside of the fence at a utility-scale solar facility or electrical substation it is impossible to get very close to the EMF sources. Because of this, EMF levels at the fence of electrical substations containing high voltages and currents are considered "generally negligible"..[71, 72]

The strength of ELF-EMF present at the perimeter of a solar facility or near a PV system in a commercial or residential building is significantly lower than the typical American's average EMF exposure..[73, 74] Researchers in Massachusetts measured magnetic fields at PV projects and found the magnetic fields dropped to very low levels of 0.5 mG or less, and in many cases to less than background levels (0.2 mG), at distances of no more than nine feet from the residential inverters and 150 feet from the utility-scale inverters..[75] Even when measured within a few feet of the utility-scale inverter, the ELF magnetic fields were well below the International Commission on Non-Ionizing Radiation Protection's recommended magnetic field level exposure limit for the general public of 2,000 mG..[76] It is typical that utility scale designs locate large inverters central to the PV panels that feed them because this minimizes the length of wire required and shields neighbors from the sound of the inverter's cooling fans. Thus, it is rare for a large PV inverter to be within 150 feet of the project's security fence.

Anyone relying on a medical device such as pacemaker or other implanted device to maintain proper heart rhythm may have concern about the potential for a solar project to interfere with the operation of his or her device. However, there is no reason for concern because the EMF outside of the solar facility's fence is less than 1/1000 of the level at which manufacturers test for ELF EMF interference, which is 1,000 mG..[77] Manufacturers of potentially affected implanted devices often provide advice on electromagnetic interference that includes avoiding letting the implanted device get too close to certain sources of fields such as some household appliances, some walkie-talkies, and similar transmitting devices. Some manufacturers' literature does not mention high-voltage power lines, some say that exposure in public areas should not give interference, and some advise not spending extended periods of time close to power lines..[78]

3. Electric Shock and Arc Flash Hazards

There is a real danger of electric shock to anyone entering any of the electrical cabinets such as combiner boxes, disconnect switches, inverters, or transformers; or otherwise coming in contact with voltages over 50 Volts..[79] Another electrical hazard is an arc flash, which is an explosion of energy that can occur in a short circuit situation. This explosive release of energy causes a flash of heat and a shockwave, both of which can cause serious injury or death. Properly trained and equipped technicians and electricians know how to safely install, test, and repair PV systems, but there is always some risk of

injury when hazardous voltages and/or currents are present. Untrained individuals should not attempt to inspect, test, or repair any aspect of a PV system due to the potential for injury or death due to electric shock and arc flash, The National Electric Code (NEC) requires appropriate levels of warning signs on all electrical components based on the level of danger determined by the voltages and current potentials. The national electric code also requires the site to be secured from unauthorized visitors with either a six-foot chain link fence with three strands of barbed wire or an eight-foot fence, both with adequate hazard warning signs.

4. Fire Safety

The possibility of fires resulting from or intensified by PV systems may trigger concern among the general public as well as among firefighters. However, concern over solar fire hazards should be limited because only a small portion of materials in the panels are flammable, and those components cannot self-support a significant fire. Flammable components of PV panels include the thin layers of polymer encapsulates surrounding the PV cells, polymer backsheets (framed panels only), plastic junction boxes on rear of panel, and insulation on wiring. The rest of the panel is composed of non-flammable components, notably including one or two layers of protective glass that make up over three quarters of the panel's weight.

Heat from a small flame is not adequate to ignite a PV panel, but heat from a more intense fire or energy from an electrical fault can ignite a PV panel..[80] One real-world example of this occurred during July 2015 in an arid area of California. Three acres of grass under a thin film PV facility burned without igniting the panels mounted on fixed-tilt racks just above the grass..[81] While it is possible for electrical faults in PV systems on homes or commercial buildings to start a fire, this is extremely rare..[82] Improving understanding of the PV-specific risks, safer system designs, and updated fire-related codes and standards will continue to reduce the risk of fire caused by PV systems.

PV systems on buildings can affect firefighters in two primary ways, 1) impact their methods of fighting the fire, and 2) pose safety hazard to the firefighters. One of the most important techniques that firefighters use to suppress fire is ventilation of a building's roof. This technique allows superheated toxic gases to quickly exit the building. By doing so, the firefighters gain easier and safer access to the building, Ventilation of the roof also makes the challenge of putting out the fire easier. However, the placement of rooftop PV panels may interfere with ventilating the roof by limiting access to desired venting locations.

New solar-specific building code requirements are working to minimize these concerns. Also, the latest National Electric Code has added requirements that make it easier for first responders to safely and effectively turn off a PV system. Concern for firefighting a building with PV can be reduced with proper fire fighter training, system design, and installation. Numerous organizations have studied fire fighter safety related to PV. Many organizations have published valuable guides and training programs. Some notable examples are listed below.

- The International Association of Fire Fighters (IAFF) and International Renewable Energy Council (IREC) partnered to create an online training course that is far beyond the PowerPoint click-and-view model. The self-paced online course, "Solar PV Safety for Fire Fighters," features rich video content and simulated environments so fire fighters can practice the knowledge they've learned. www.iaff.org/pvsafetytraining
- Photovoltaic Systems and the Fire Code: Office of NC Fire Marshal
- Fire Service Training, Underwriter's Laboratory

- Firefighter Safety and Response for Solar Power Systems, National Fire Protection Research Foundation
- Bridging the Gap: Fire Safety & Green Buildings, National Association of State Fire Marshalls
- Guidelines for Fire Safety Elements of Solar Photovoltaic Systems, Orange County Fire Chiefs Association
- Solar Photovoltaic Installation Guidelines, California Department of Forestry & Fire Protection, Office of the State Fire Marshall
- PV Safety & Firefighting, Matthew Paiss, Homepower Magazine
- PV Safety and Code Development: Matthew Paiss, Cooperative Research Network

Summary

The purpose of this paper is to address and alleviate concerns of public health and safety for utility-scale solar PV projects. Concerns of public health and safety were divided and discussed in the four following sections: (1) Toxicity, (2) Electromagnetic Fields, (3) Electric Shock and Arc Flash, and (4) Fire. In each of these sections, the negative health and safety impacts of utility-scale PV development were shown to be negligible, while the public health and safety benefits of installing these facilities are significant and far outweigh any negative impacts.

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